DRAFT

San Clemente Shoreline Feasibility Study
Orange County, California

F-3
Without Project Conditions

U.S. Army Corps of Engineers
Los Angeles District

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SAN CLEMENTE SHORELINE FEASIBILITY STUDY

DRAFT F-3 MAIN REPORT

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SAN CLEMENTE SHORELINE, CA
FEASIBILITY STUDY
DRAFT F3 REPORT

1.0 INTRODUCTION

1.1 Study Authority

This report was prepared as an interim response to the following authority:

Section 208 of the River and Harbor Act of 1965, which reads:

"The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the localities specifically named in this section. …
Coasts of Washington, Oregon, and California to determine advisability of protection work against storm and tidal waves."

In response to the study authority the reconnaissance phase of the study was initiated on March 28, 2000. This phase of the study resulted in the finding that there was a Federal interest in continuing the study into the feasibility phase. The City of San Clemente as the non-Federal sponsor, and the U.S. Army Corps of Engineers (Corps) initiated the feasibility phase of the study on September 2001. The feasibility phase study cost was shared equally between the Corps and the sponsor. This report presents the preliminary results of both phases of study.

1.2 Study Purpose and Scope

The purpose of this report is to present the preliminary findings of a feasibility investigation which was conducted to determine if there is a Corps interest in providing protection against damages caused by coastal storms and to restore the recreation beaches along the coast of the City of San Clemente in Orange County, CA. This report analyzes the problems and opportunities and expresses desired outcomes as planning objectives. Alternatives are then developed to address these objectives. These alternatives include a plan of no action and various combinations of structural and non-structural measures. The economic and environmental impacts of the alternatives are then evaluated and a preferably feasible plan is tentatively selected. The report also presents details on Corps and sponsor participation needed to implement the plan. The report concludes with a recommendation for authorization.

The scope of the study included all investigations needed to formulate a proposed plan to address the study purposes. The scope involved characterizing the existing and future physical, economic, and environmental conditions related to the study area; identifying causes and magnitudes of problems and opportunities related to the coastal environment; developing and evaluating alternative plans based on considering costs, benefits, environmental, regional development, and community/social impacts caused by the alternatives, and selecting the recommended plan. The investigations accomplished included surveys, offshore exploration of sediments, coastal engineering studies, economic studies, environmental studies, and real estate studies as necessary to derive reasonable estimates to determine the feasibility of a Federal project, and to define project requirements.

The scope also included investigations and analysis needed to respond to all regulatory requirements for implementing the proposed recommended plan including preparation of a combined Environmental Impact Statement/ Environmental Impact Report in accordance with the National Environmental Policy Act (NEPA) and California Environmental Quality Act; solicitation of the views from Federal and State fish and wildlife agencies in accordance to the Fish and Wildlife Coordination Act; preparation of A Coastal Consistency Determination in accordance with the Coastal Zone Management Act; completion of assessments required by the Clean Water Act and Clean Air Act; evaluation of impacts to cultural and historic resources in accordance with National Historic Preservation Act; and other Federal and State laws and policies related to preserving and protecting the environment and communities.

1.3 Study Participation And Coordination

The Feasibility Study was performed as a 50-50 cost shared partnership between the Corps of Engineers and the City of San Clemente, under provisions of Feasibility Cost Sharing Agreement executed in September 2001. The study included coordination with all appropriate Federal, State, County and local agencies, groups, and interested individuals. These entities provided pertinent data and professional insight into the perceived problems and needs of the study area. They also provided data and analyses as input into the development, assessment and evaluation of the alternative solutions and the selection of the Recommended Plan.

The non-Federal sponsor of the Study is the City of San Clemente, whose representatives took an active role in the conduct of the total Study effort.

Agencies included in the coordination process include the following:

Federal Agencies

U.S. Coast Guard
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. National Marine Fisheries Service

State Agencies

California Coastal Commission
California Department of Fish and Game
California Department of Boating and Waterways
California Regional Water Quality Control Board
Office of Historic Preservation

Local Agencies

City of San Clemente
South Coast Air Quality Management District
Southern California Regional Railroad Authority
Orange County Transportation Authority
Metrolink

1.4. Public Involvement And Communication

A major consideration for the City of San Clemente and the Corps of Engineers in formulating and selecting a recommended plan is consideration of the acceptability of the plan to public interests. The study included several public involvement activities to allow for public interests to provide input, and their views and comments on the study area, conditions, problems, and needs, alternative plans, and the selected recommended plan. The public involvement activities and views and comments received are presented in Chapter 6 of the main report as well as the Coordination Chapter of the EIS/EIR.

1.5 Prior Studies, Reports And Existing Water Projects

a. The following reports are being reviewed as directed in the study authorization:

2. *State of the Coast Report, San Diego Region, River Sediment Discharge Study Report*, Corps of Engineers, 1988. This report presents the findings of a study estimating the sediment delivery to the coast from streams and watersheds draining to the California Coast in the San Diego Region, which extended north to the Dana Point headlands. It concludes that 90% of the average annual yields of sands came from major rivers and the other 10% yielded from coastal streams.

3. *State of the Coast Report, Coast of California Storm and Tidal Wave Study, San Diego Region, Littoral Zone Sediments Report*, Corps of Engineers, 1988. This report presents the findings from the collection, analysis, and interpretation of sedimentologic data from the littoral zone. From the findings, littoral segments along the southern California coast and the most likely transport direction within each of these littoral segments are defined.

4. *State of the Coast Report, San Diego Region, Historic Wave and Sea Level Data Report*, Corps of Engineers, 1988. This report presents statistically analyzed historic wave data and recent wave hindcasts for Southern Hemisphere swells and tropical storms that have impacted the San Diego region. The tide regime, historic and predicted extremes of sea level, and a chronology of extreme storm events are also presented.

5. *State of the Coast Report, Coast of California Storm and Tidal Wave Study, San Diego Region, Main Report*, Corps of Engineers, 1991. This report suggests that the condition of the beaches in the future will be governed by cycles of accretion and erosion similar to those of the past 50 years, but with accelerated trends toward erosion because of the reduction in fluvial delivery due to impediment by dams and

river mining, the influence of Oceanside Harbor interrupting alongshore sediment transport, and the increasing rate of sea level rise.

6. *Wave Information Studies of US Coastlines, Southern California Hindcast Wave Information*, Corps of Engineers, 1992. This report presents hindcast wave information from 1956 to1975 for the region south of Point Conception to the Mexican border. The sources of wave energy and local effects that control the wave climate included in this report consists of northern Pacific swell, east Pacific wind fields and associated waves, localized effects such as sheltering and diffraction by islands, and meso-scale meteorological systems such as land-sea breezes.

7. *Strategic Rail Corridor Network (STRACNET) and Defense Connector Lines*, Military Traffic Command, Transportation Agency, 1998. This study updates the designation of the Strategic Rail Corridor Network (STRACNET) and its associated connector lines to verify that the rails meet defense readiness requirements for maintenance condition, clearance, and gross weight capability. STRACNET maintains a rail line running parallel to the coastline throughout the City of San Clemente.

8. *Oceanographic Design Conditions for the Repair of the San Clemente Pier*, Moffatt & Nichol Engineers, 1983. This report documents oceanographic data from the 1982-1983 winter storms, which destroyed approximately 134 meters (440 feet) of the San Clemente Pier. Design suggestions from this data and previous storm data are proposed for the repair of the pier.

9. *Beach Width and Profile Surveys,* City of San Clemente, 2000 & 2002. Results of beach width measurements taken by the City at 16 locations in 1958, 1981 and 1999 are presented. Also, results of benthic elevations along the pier from 1981 to the present are provided. The data indicates that there has been a significant increase in the loss of sand along the City's coastal stretch.

10. *Draft Mitigated Negative Declaration, Marblehead Coastal Beach Replenishment Project,* City of San Clemente, 2000. This CEQA document describes a private beach nourishment project along the San Clemente shoreline.

b. There are no existing Federal Shore Protection Projects in the Study area.

2.0 STUDY AREA

2.1 Location and Description

The San Clemente Shoreline Feasibility Study area, as presented in **Figure 2-1**, is located along the Pacific Ocean coastline in the City of San Clemente, Orange County, California. San Clemente is the southernmost city in Orange County and is bounded by the Camp Pendleton Marine Base and San Onofre State Beach Park to the south; and to the north, by the communities of Capistrano Shores and Dana Point. The total study area encompasses the City of San Clemente and extends from San Mateo Point, located at the southern boundary of the City, to Dana Point Harbor for a total distance of approximately 12.1 kilometers (7.5 miles).

The City of San Clemente's shoreline, which extends from San Mateo Point to Shorecliff Beach, is approximately 8 kilometers (5 miles) in length. Narrow sandy beaches, on the order of 10 to 30 meters, backed by high coastal bluffs and pockets of coastal development and infrastructure characterize the City's shoreline. The gently to moderately sloping sandy beaches grade into a foreshore consisting of gravel and cobble at the water line in several locations.

Running along the entire length of the study area is a major railroad corridor linking the coastal communities of southern California to the greater Los Angeles and San Diego metropolitan areas. The Southern California Regional Railroad Authority (SCRRA), a public associated agency, operates this corridor, which is one of the busiest in the nation. The railroad is constructed on conventional elevated crush rock ballast and is a prominent feature within the study area and effectively separates the beach area from the coastal bluffs. Historically, riprap has been placed along the seaward side of the corridor to protect the rail line from storm wave attack. The existing railroad revetment provides varying levels of protection depending on the rock size and conditions of the riprap for both the rail line and development and infrastructure improvements landward of it.

To better analyze the interaction between the coastal bluffs, the railroad corridor and the shoreline morphology, the entire study area has been divided into ten reaches, as illustrated below. The distinction between reaches is based on differences in topography, coastal development and beach conditions. The locations and limits of each of the ten study reaches are presented in **Table 2-1** and are illustrated in **Figure 2-1**.

2.1.1 Reach 1 – San Mateo Point to Palmeras (Sta: 0+146 to Sta: 1+115)

The southernmost shoreline segment extending from San Mateo Point to Avenida de las Palmeras (**Figure 2-2**) is approximately 1.0 kilometer in length and can be characterized as having little to no beach area at San Mateo Point, which gradually increases to approximately 41 meters (134.5 feet) at the northern limit of the reach. The railroad corridor traverses through this segment immediately landward of the dry beach and is protected by armor stone along its seaward face at a slope of 1H:1V (which is a ratio of 1 horizontal unit to 1 vertical unit) with an approximate crest elevation of +6.9 meters (+22.6 feet), Mean Lower Low Water (MLLW). The elevation of the tracks is approximately +6.4 meters (+21.0 feet), MLLW.

Table 2-1: Study Area Reaches

Reach	Range		Approximate Length (m)
	From	To	
1	San Mateo Point	Palmeras	969
2	Palmeras	3800 Block, Vista Blanca	680
3	3800 Block, Vista Blanca	Calafia	600
4	Calafia	Primavera	732
5	Primavera	Cristobal	413
6	Cristobal	Linda Lane	1,040
7	Linda Lane	1200 Block, Buena Vista	1,081
8	1200 Block, Buena Vista	Pico	347
9	Pico	San Andreas	1,101
10	San Andreas	Dana Point Harbor	5,000

Although no structures exist seaward of the railroad tracks, residential development immediately landward of the corridor exists throughout this coastal segment and is afforded a certain level of protection from coastal storm related impacts by the existing armor stone revetment.

2.1.2 Reach 2 – Palmeras to 3800 Block, Vista Blanca (Sta: 1+115 to Sta: 1+795)

The shoreline segment between Avenida de las Palmeras and the 3800 block of Vista Blanca (**Figure 2-3**) is approximately 0.7 kilometers in length and can be characterized as having a narrow to moderate sized beach that is backed by the railroad corridor located at the base of high coastal bluffs. Beach widths range from approximately 40 meters (131.2 feet) at the southern boundary to approximately 9 meters (29.5 feet) at the northern boundary. Similar to Reach 1, the elevated railroad incorporates conventional crushed rock ballast construction; however, no revetment currently exists to protect the tracks along this portion of the shoreline.

Bluff top residential coastal development and infrastructure exists throughout the southern half of the reach landward of the rail line, while the railroad corridor effectively separates San Clemente State Beach from thick, well vegetated coastal bluffs along the northern portions of the coastal segment. Due to the natural topography and coastal bluff configuration landward of the San Clemente State Beach area, residential coastal development is setback for a considerable distance from the shoreline.

2.1.3 Reach 3 – 3800 Block, Vista Blanca to Calafia (Sta: 1+795 to Sta: 2+395)

The shoreline segment between the 3800 block of Vista Blanca and Avenida Calafia is approximately 0.6 kilometers in length and encompasses San Clemente State Beach and Calafia Beach Park (**Figure 2-4**). The beach is subject to seasonal variability; however, recent surveys indicate that the beach width over much of the reach is narrow to non-existent as the southern portion exhibits a beach width of 9 meters (29.5 feet), which quickly becomes zero throughout the remainder of the segment.

The railroad bisects this reach at the base of thickly vegetated coastal bluffs comprised of the San Mateo Formation and is protected by a non-engineered armor stone revetment along its seaward side. The coastal bluffs are structurally stable in this region, but are subject to erosion resulting from surface runoff.

No coastal development structures exist seaward of the railroad tracks; however, public facilities associated with Calafia State Beach and bluff top residential development are present landward of the tracks. These structures are afforded a certain level of protection by the non-engineered revetment and the natural setback position of the bluff top residential development.

2.1.4 Reach 4 – Calafia to Primavera (Sta: 2+395 to 3+127)

The shoreline between Avenida Calafia and Calle Primavera may be characterized as consisting of narrow to moderate sized beaches as the beach width transitions between approximately 10 and 60 meters (33 and 197 feet) throughout the entire reach (**Figure 2-5**). The southern 30 percent of the reach is comprised of San Clemente State Beach and the remaining northern 70 percent of the reach is considered to be the southern limit of the City of San Clemente beach area.

The railroad corridor bisects this reach along the backbeach area and is constructed from conventional crushed rock ballast at a slope of 1H:1V. A non-engineered armor stone revetment existing throughout the reach protects the tracks from storm wave attack.

Although no coastal development is present seaward of the corridor, structures and infrastructure do exist immediately landward, which are afforded a certain level of protection from the revetment. In addition, coastal development along the bluff top is fairly well protected, as the bluffs are setback a considerable distance from the beach area.

2.1.5 Reach 5 – Primavera to Cristobal (Sta: 3+127 to Sta: 3+540)

The shoreline segment extending from Calle Primavera to Paseo de Cristobal is fully encompassed by the City of San Clemente and is approximately 0.4 kilometers in length. The coastal reach can be characterized as consisting of a narrow to non-existent beach backed by high coastal bluffs that are bisected by the railroad corridor (**Figure 2-6**). The coastal bluffs are comprised of the San Mateo Formation, which is a poorly cemented, well-consolidated, massively bedded, coarse sandstone standing in steep slopes. The formation is not typically prone to sliding; however, it is susceptible to upland erosion and rilling. The thin sand lens in the northern portions of the reach, specifically in the vicinity of Paseo de Cristobal, gradually transitions to cobble and a harder substrate reef extending seaward from the waterline. As such, this area is a popular location amongst surfing enthusiasts.

As in the preceding reaches, the railroad is constructed from the conventional crushed rock ballast at a 1H:1V slope and is protected by a non-engineered revetment consisting of armor stone of varying sizes. Due to the relatively narrow beach area in this reach, wave and overtopping impacts resulting from large winter storms have been known to adversely impact the rail corridor.

Although no structures exist seaward of the railroad tracks, coastal structures and infrastructure are located directly landward of the railroad. In addition, bluff top development that is setback from the backbeach and protected at the toe by the elevated rail line exists throughout the reach.

2.1.6 Reach 6 – Cristobal to Linda Lane (Sta: 3+540 to Sta: 4+580)

The shoreline segment between Paseo de Cristobal and Linda Lane is approximately 1.1 kilometers in length and may be characterized as consisting of moderate to non-existent beaches over much of the reach (**Figure 2-7**). Beach widths vary anywhere from 0 to 39 meters (0 to 128 feet) depending on the location within the segment. The beaches are backed by park facilities, railroad tracks, and high coastal bluffs.

The railroad bed is founded on the backbeach at the toe of the bluffs and is constructed from conventional crushed rock ballast with a slope of 1H:1V. The railroad corridor along this section of coast is not protected by a non-engineered revetment and, as such, is prone to winter storm related wave impacts and potential closures.

Coastal residential development, parks and public facilities, infrastructure and beach recreation are the most abundant within this coastal segment. Some of these structures include the San Clemente Municipal Pier and underpass access, Marine Safety Building, public restrooms, picnic facilities and the T-Street overpass. In addition, development along the sloped bluffs adjacent to the pier is founded on an ancient landslide.

The San Clemente Municipal Pier is located in the northern half of the reach and was originally constructed around 1928. In its current state, the pier is approximately 390 meters (1,280 feet) long and has a typical deck width of about 6.4 meters (21 feet) and a deck elevation ranging from +7.2 meters, MLLW near the pier head to +8.3 meters, MLLW at the seaward end. A restaurant occupies the base portion of the pier with three smaller structures; including a snack shop, watchtower, and restroom located further seaward. The landward portion of the pier has timber piles, caps and decking while the seaward 440 feet of the pier has been reconstructed with steel members as this portion of the pier was destroyed by large swells on March 1-2, 1983 from an intense storm moving eastward from the central Pacific Ocean. This storm, which caused in excess of $800,000 in damage to the pier, was one of a series of severe storms occurring during the winter of 1982-1983 causing extensive damages and warranting a major disaster declaration in many areas of the State of California.

The Marine Safety Building is located on the beach approximately 183 meters (600 feet) north of the pier. The building, which is an approximate 465 square meters (5,000 square feet) single story timber frame structure, has been under increased risk due to wave attack. An extensive amount of sand that at one time provided a buffer between the waves and the building has since eroded away to the point where the piles that support the most seaward portion of the building are exposed. As a result, an emergency sheet pile wall has been placed in front of the building to help protect the foundation from wave attack.

2.1.7 Reach 7 – Linda Lane to 1200 Block, Buena Vista (Sta: 4+580 to Sta: 5+661)

The shoreline segment extending from Linda Lane to the 1200 block of Buena Vista is approximately 1,081 meters in length and is fully encompassed within the City of San

Clemente (**Figure 2-8**). Mariposa Point, which is approximately 300 meters northwest of the San Clemente Municipal Pier, is located in the center of this coastal reach. Offshore rocks and boulders protrude from the high intertidal sand beach and becomes the dominant habitat throughout the mid and low intertidal zones. The last extensive rocky intertidal habitat at Mariposa Point consists of a series of low-lying shale reef platforms that begin in the mid-beach area and extend into the subtidal zone along with individual high relief boulders. Due to the high relief of the hard substrate in this area, the beach width throughout the reach is non-existent and during high tides it is difficult to walk along the beach around Mariposa Point without getting wet.

The railroad corridor transects the shoreline in close proximity to the high intertidal zone in this area. As such, historical information indicates that the tracks have been protected from storm wave attack and high water levels with a revetment since at least the 1930's that incorporates the use of 1 to 5 ton armor stone.

Although coastal development and infrastructure exist atop the coastal bluffs, no structures exist either seaward or landward of the railroad corridor along the back beach zone. However, a pedestrian and railroad access dirt path is evident immediately adjacent to the tracks on the landward side throughout much of the reach.

2.1.8 Reach 8 – 1200 Block, Buena Vista to Pico (Sta: 5+661 to Sta: 6+008)

The shoreline segment between the 1200 block of Buena Vista and Avenida Pico is approximately 347 meters in length and may be characterized as consisting of a moderate to non-existent beach area that is backed by the railroad corridor located at the toe of the coastal bluffs (**Figure 2-9**). This coastal zone represents the area known as North Beach, located just south of Capistrano Shores.

The railroad corridor track elevation is approximately +6.4 meters, MLLW and incorporates conventional ballast construction. Development along this reach consists of some residential beachfront development, the north beach concession stand, and public restroom facilities. In addition, storm water runoff from the Poche Creek Storm Drain discharges the flow to the back beach area underneath an elevated railroad corridor overpass (see **Figure 2-10**). Shoreline and coastal development protection is limited and sporadic within this reach.

2.1.9 Reach 9 – Pico to San Andreas (Sta: 6+008 to Sta: 7+109)

The shoreline segment between Avenida Pico and Via San Andreas is approximately 1.1 kilometers in length and is known as Capistrano Shores within the City of San Clemente (**Figure 2-10**). The beach width within this coastal zone may be considered to be primarily non-existent. Coastal development is backed by the railroad corridor followed by Pacific Coast Highway and the cliffs. The cliff rim and elevated coastal plain are extensively developed with residential buildings.

The railroad corridor is located substantially landward of the coastal development, and as a result, is not considered to be the project seaward boundary within this reach. The development seaward of the railroad is known as the Capistrano Shores mobile home community and is sited on what was historically the active backbeach. As such, marine erosion has left the development with inadequate setback distances and little to no beach protection from storm induced wave and flood damage.

Shoreline protection exists within this reach along the mobile home community and consists of a timber seawall in poor condition, fronted by armor stone ranging in size from 5 to 7 tons at an approximate 1H:1.5V slope. The timber seawall armored with riprap was originally constructed in the late 1960's and has return sections on both the northwest and southeast ends extending landward for approximately 12.2 meters (40 feet). During the 1997-1998 El Nino season, severe storm waves attacked and overtopped the seawall causing a number of armor stones to become dislodged from the revetment. Although Capistrano Shores, Inc., the property manager for the mobile home community, repaired the seawall under an emergency permit; they are still in the process of procuring a permanent shoreline protection permit from the California Coastal Commission.

2.1.10 Reach 10 – San Andreas to Dana Point Harbor (Sta: 7+109 to Sta: 12+109)

The shoreline segment between Via San Andreas and Dana Point Harbor is the northernmost reach within the study area and is approximately 5.0 kilometers in length (**Figure 2-11**). This reach is located immediately south of Dana Point Harbor and primarily encompasses residential coastal development along Camino Capistrano, public recreational vehicle camping and parking facilities, and Doheny State Beach and Park. The beach within this reach may be characterized as ranging between narrow to moderate in width and is backed by the aforementioned development, the railroad corridor, Pacific Coast Highway, and the coastal bluffs, respectively.

Similar to Reach 9, the coastal bluff top and elevated coastal plain are extensively developed with residential buildings as well. The cliffs, which are comprised of intensely fractured, massive to poorly bedded siltstone, are developed extensively with residential development and infrastructure. During the wet year of 1992 – 1993, a bluff failure occurred resulting in a large slide that blocked Pacific Coast Highway and the railroad tracks endangering several bluff top homes near Poche Beach (southeastern end of reach).

The north end of the reach near San Juan Creek and Doheny State Beach received nearly 1 million cubic yards of sand nourishment between 1966 and 1970 (Shaw, 1980) resulting from upland construction improvements on Camp Pendleton near Basilone Road. Although the residential coastal development is not protected with hardened structures, Dana Point and the harbor breakwater provide moderate sheltering from west and northwesterly swell. In addition, Santa Catalina and the San Clemente Islands provide some sheltering from southwesterly swells. As a predominantly south facing beach, this reach is exposed to intense, short duration subtropical hurricanes originating off the coast of Mexico.

2.2 Physical Characteristics

2.2.1 Topography

Terrestrial topographic data were obtained from March 2002 aerial LIDAR surveys conducted as a part of this study. LIDAR (<u>LI</u>ght <u>D</u>etection <u>A</u>nd <u>R</u>anging) is a state-of-the-art survey system that allows high-speed collection of topographic data. The system employs a helicopter-mounted range-finding laser that is coupled with a highly accurate GPS positioning system to collect precise GPS measurements, platform attitude, laser ranges, and imagery data. Topographic information was collected at a horizontal point spacing on the order of 0.1 meter that allowed detailed information to be collected of the beach, revetment, railroad, and ground elevations adjacent to structures throughout the study area. In addition, detailed mapping in the damage/flood areas provided existing beach contours, beach widths, berm elevations, foreshore slopes, and the back beach horizontal position of coastal structures.

2.2.2 Bathymetry

The bathymetry within the San Clemente project study area is presented in **Figure 2-12**. The water depths in the survey area range from 3 meters near the beach to 23 meters offshore. The seafloor slope direction is southwest or normal to the beach. The seafloor gradient averages 0.9 percent but varies locally. The inshore gradient between the 3 to 6-meter water depth is approximately 5 percent in the San Clemente State Beach area and decreases in a northwestward fashion as one travels from San Mateo Point to Dana Point Harbor. Several bedrock spurs extend out from shore; the largest one is the seaward extension of San Mateo Point, which may rise several meters above the intervening swales. The San Mateo Rocks northwest of San Mateo Point are isolated and may be remnant spurs. Bedrock outcrops the seafloor in places between the shore and about the 15-meter isobath. Where outcrops occur, the seafloor is uneven from the resistant bedrock mounds. Some of the larger outcrops rise as much as 6 meters above the surrounding seabed. The gradients along some of these outcrop slopes can be as high as 33 percent (18^{o}). A smooth seafloor with an even slope forms the topography seaward of the outcrops. This smooth texture is a result of unconsolidated recent sediment deposition.

Side scan sonar data of the area, performed in May 2002, clearly show areas where bedrock is exposed. In several locations, survey data could not be acquired, as the kelp was too thick to navigate through. It is well established that bedrock is necessary for kelp growth. The bedrock exposures are mapped as either areas where exposures comprise greater than 50 percent of the seabed and zones where scattered rocks cover 10 – 50 percent of the area. Unconsolidated surficial sediment predominates in the scattered rock zones. The subbottom profile data reveal an immeasurably thin surficial veneer overlies the bedrock. This thin sand lens likely changes seasonally as beach sands migrate in a cross-shore direction.

2.3 Geologic Characteristics

The San Clemente area comprises a part of the western flank of the Peninsular Range Geologic Province of southern California and includes areas of the western foothills of the Santa Ana Mountains and the southeastern flank of the San Joaquin Hills. The Peninsular Range extends from the Palos Verdes Peninsula in the north to the tip of Baja California in the south. The bedrock exposure in the area is comprised of marine sedimentary and volcanic rocks of Miocene, Pliocene and Pleistocene age. The bedrock formations both onshore and offshore consist of the San Mateo Formation, an arkosic sandstone of Pleistocene age, the Capistrano Formation, a series of silty shales, mudstones, siltstones and coarse sandstones of late Miocene and early Pliocene age and the San Onofre Breccia which is a series of volcanic breccias, ash flows and tuffs derived from large landslides during volcanic eruptions interbeded with layers of fine-grained volcanic ash deposited into fresh or salt water and is of Miocene age.

2.3.1 Onshore Geology

As result of marine erosion within the San Clemente Shoreline Feasibility study area, a broad wave-cut terrace has formed extending back from the coastline and lying several meters above sea level. This relatively flat surface is cut mainly in rocks of the Capistrano Formation of late Miocene and early Pliocene age and is mantled with poorly consolidated non-marine alluvial cover of Holocene and Pleistocene age and marine terrace deposits of Upper Pleistocene age. The non-marine cover consists of poorly bedded fine-grained sediments. The marine terrace deposits consist of poorly consolidated sands, sandstones and conglomerates. The beach, which begins at the foot of the wave-cut terrace, is composed of fine to medium grained sands and silty sands. Because of various seasonal cycles of sand deposition and erosion and the lack of adequate natural beach renourishment cycles in the area, the beach varies in width from 0 to 60 meters (0 to 200 feet).

2.3.2 Offshore Geology

The area offshore of San Clemente is a part of the Capistrano Bight, located at the eastern edge of the Gulf of Santa Catalina. This area is described as that part of the California coast known as the “Continental Borderland”, as there is no real continental shelf in this part of the coast. The area from Dana Point Harbor in Orange County downcoast to La Jolla in San Diego County is further defined as the “Oceanside Littoral Cell”. The City of San Clemente’s shoreline is located in the extreme upper portion of this Littoral Cell.

The detailed local offshore site geology and bedrock location identification was determined by a seismic survey plus 10 vibracore test holes drilled and sampled at random locations offshore of the City of San Clemente. The seismic survey was accomplished during the summer of 2002 and the vibracore sampling was accomplished from December 2002 through January 2003. The bathymetric survey indicates that the ocean bottom slopes gradually seawards for a distance of about 1,500 meters (0.93 miles) from elevation 0 meter, MLLW at the shoreline to an elevation deeper than -32.8 meters (-100 feet), MLLW. The accompanying geophysical surveys further indicated that the ocean floor is a bedrock surface covered with a thin veneer of littoral sediments that vary in thickness from approximately 0 to 0.32 meters (1-foot) or more, out to a distance of about 1,500 meters from the shoreline.

2.4 Seismicity

The geologic structure of the San Clemente study area region is the result of faulting and folding in the current tectonic regime, which began approximately 5 million years ago when the Gulf of California began to open in association with renewed movement on the San Andreas fault system (Fisher and Mills, 1991). The tectonic forces are also evident in the localized folding and faulting of the Eocene-age sediments. Some of the faults locally control the contact between formations.

The study area is located within the moderately active seismic region of Southern California that is subject to significant hazards from moderate to large earthquakes. There are several northwest to southeast trending faults in both the onshore and the offshore areas east and west of San Clemente. The Whittier-Elsinore, Agua Caliente, San Jacinto and the San Andreas Fault zones are located approximately 12.3 kilometers (20 miles), 16.5 kilometers (27 miles), 24.4 kilometers (40 miles) and 38 kilometers (62 miles) northeast of San Clemente, respectively. The Newport-Inglewood-Rose Canyon Fault lies approximately 3.1 kilometers (5 miles) offshore of the beach. The Palos Verdes Fault zone parallels the Pacific Coast offshore from the San Pedro – Long Beach area to La Jolla and lies about 10.3 kilometers (18 miles) from the coastline. The San Clemente Island Fault zone lies approximately 33 kilometers (55 miles) offshore and is parallel to the Newport-Inglewood-Rose Canyon Fault zone. These three faults trend parallel to the onshore faults. The Christianitos Fault, which is the closest fault to the project area, trends northwest to southeast and passes through the mountain ranges behind the San Clemente area and then trends down the San Mateo Creek and goes offshore to parallel the coastline near San Onofre in a southerly direction past Oceanside. The fault is located approximately ½ to 3 kilometers (1 to 5 miles) offshore of the beach within San Clemente. Ground shaking resulting from an earthquake can impact the San Clemente study area.

There have been several landslides mapped in the hills and mountains that form the eastern boundary of the San Clemente project study area. These are shown on a geologic map accompanying "Natural Slope Stability as Related to Geology, San Clemente Area, Orange and San Diego Counties, California, Special Report 98" (Blanc and Cleveland, 1968) published by the California Division of Mines and Geology. The geologic map indicates that there are seven small areas of the bluff behind the beach extending from the San Clemente Pier to San Mateo Point, which contain landslide deposits. However, since none of these slides extend into the beach zone, they are not considered to be a potential problem for future beach nourishment efforts.

2.5 Climate

2.5.1 General Climatic Conditions

The local climate is dominated by the strength and position of the semi-permanent high-pressure center over the Pacific Ocean near Hawaii. This high-pressure center results in cool summers, mild winters, and infrequent rainfall. It also drives the cool daytime breezes resulting in comfortable humidity levels and an abundance of sunshine. Based on data from the South Coast Air Quality Management District (SCAQMD), temperatures in the coastal portions of Orange County average 61°F, with average summer temperatures ranging between approximately 68 to 70°F and average winter temperatures ranging between 51 to 53°F. Rainfall averages about 0.3 meter (12 inches) per year in the coastal zones. In contrast to a very steady pattern of temperature, rainfall is both seasonally and annually highly variable, with most rain accumulations occurring between November through April. **Table 2-2** summarizes the monthly temperature and precipitation statistics as measured in Laguna Beach (approximately 20 kilometers north of San Clemente) between 1928 and 2003.

Onshore winds across the south coastal region are from a westerly and southwesterly direction during the day while easterly and northeasterly breezes predominate at night. Wind speed tends to be somewhat greater during the dry summer months than during the rainy winter season. In January, light-to-moderate winds average 6 to 10 mph and blow from the northeast to the south-southwest more than three-quarters of the time.

Table 2-2. Monthly Climatic Summary at Laguna Beach, California (1928 to 2003)

Month	Ave. Max. Temperature in ^{O}F	Ave. Min. Temperature in ^{O}F	Ave. Total Precipitation cm (in)
January	65.0	43.0	6.35 (2.50)
February	66.0	44.1	6.99 (2.75)
March	66.9	45.6	5.33 (2.10)
April	68.9	48.4	2.46 (0.97)
May	70.6	52.9	0.66 (0.26)
June	72.8	55.9	0.28 (0.11)
July	76.3	59.2	0.05 (0.02)
August	77.9	59.6	0.18 (0.07)
September	77.4	58.2	0.66 (0.26)
October	74.5	53.7	1.09 (0.43)
November	70.4	47.5	3.25 (1.28)
December	66.1	43.4	4.90 (1.93)

Source: Western Regional Climate Center (Station No. 044647)

This flow is reversed during the day and the wind predominantly originates from the southwest at an average of 5 to 8 mph. Light winds averaging 3 to 6 mph originate from the east or southeast at night during July. This trend reverses during the day when winds predominate from the southwest, averaging 10 to 15 mph during the afternoon. In addition, extensive surface high-pressure systems over the Great Basin, combined with other meteorological conditions, can result in very strong, down slope “Santa Ana” winds during, especially, the winter and fall months. These winds may continue for a few days before “typical” circulation patterns recur.

2.5.2 El Nino Southern Oscillation Events (ENSO)

Southern Oscillation El Nino (ENSO) events are global-scale climatic variations with a duration lasting for approximately 2 to 7 years. They represent an oscillatory exchange of atmospheric mass as manifest by a decrease in sea surface pressure in the eastern tropical Pacific Ocean, a decrease in the easterly trade winds, and an increase in sea level on the west coast of North and South America (USACOE-LAD, 1986). The interaction between the atmospheric and oceanic environment during these events drive climatic changes that can result in significant modifications of wave climate along the world’s coasts.

The severe winter seasons of 1982-1983 and 1997-1998, which produced some of the most severe storms to ever impact the Encinitas and Solana Beach coast, were the result of intense ENSO events. The atmospheric disturbance associated with these two events caused abnormally warm water temperatures, an actual reversal of the easterly trade winds, and increased the monthly mean sea levels by as much as 0.13 meters (0.42 feet) in 1982-1983 season and 0.16 meters (0.52 feet) in 1997-1998 season at La Jolla, San Diego (Flick, 1998).

2.6 Coastal Processes

2.6.1 Water Levels, Tides and Sea Level Rise

Water levels within the surf zone consist of three primary factors within southern California: 1) astronomical tides, 2) storm surge and wave set-up, and 3) short-term climatic variations related to ENSO events, and 4) global long-term rise in sea level.

Tides

Tides along the southern California coastline are of the mixed semi-diurnal type. Typically, a lunar day (approximately 25 hours) consists of two high and two low tides, each of different magnitudes. A lower low tide normally follows the higher high tide by approximately seven to eight hours while the time to return to the next higher high tide (through higher low and lower high water levels) is usually approximately 17 hours. Annual tidal peaks typically occur during the summer and winter seasons. The increased tidal elevations during the winter season can exacerbate the coastal impacts of winter storms.

Since tides have a spatial scale on the order of hundreds of kilometers, the prevailing tidal characteristics measured in La Jolla may be considered representative of the tidal elevations within the project area. The National Oceanic and Atmospheric Administration (NOAA) has established tidal datums for the La Jolla tidal station in San Diego County, approximately 81 kilometers (50 miles) southeast of the San Clemente pier, based on 19 years of collected measurements from the 1960 through 1978 tidal epoch. The tidal characteristics at the La Jolla tidal station, referenced to the Mean Lower Low Water (MLLW) vertical datum are presented in **Table 2-3**. The highest recorded sea level at the La Jolla gage located at the terminus of the Scripps Pier was 2.38 meters (7.81 feet), MLLW measured on August 8, 1993.

In addition, it is worthy to note that the National Ocean Service (NOS) recently updated the La Jolla primary tide gage in order to re-compute the Mean Lower Low Water (MLLW) vertical datums for the 19-year tidal epoch extending from 1983 through 2001.

Table 2-3. Tidal Characteristics at Scripps Pier in La Jolla, California (San Diego County)

Datum Plane	Elevation, meters (feet), MLLW
Highest observed water level (Aug. 8, 1993)	+2.38 (+7.81)
Mean Higher High Water (MHHW)	+1.64 (+5.39)
Mean High Water (MHW)	1.41 (+4.63)
Mean Tide Level (MTL)	0.85 (+2.78)
Mean Sea Level (MSL)	0.85 (+2.78)
National Geodetic Datum – 1929 (NGVD)	0.78 (+2.56)
Mean Low Water (MLW)	0.28 (+0.92)
Mean Lower Low Water (MLLW)	0.00 (0.00)
Lowest observed water level (Dec. 17, 1933)	-0.79 (-2.60)

Source: National Ocean Service (NOS), 2003

Storm Surge and Wave Setup

Storm surge is the super-elevation of the tidal level at the coast due to wind stresses and atmospheric pressure fluctuations acting upon the sea surface. Wind and atmospheric fluctuations associated with strong storms in southern California typically produce 0.3-0.6 meters (1-2 feet) storm surges (CCSTWS-SD, 1991). Due to a narrow continental shelf and the absence of tropical storms and/or hurricanes, storm surge heights on the California coast are small compared to those on the east and Gulf coasts where extreme surge heights of 1-3 meters (3-10 feet) are more typical and a peak 8 meters (25 feet) was documented during Hurricane Camille in 1969. The winter storm of January 17 and 18, 1988 produced the all time record low barometric pressure for southern California. The still water level measured at the Los Angeles Harbor gage during this event was approximately 0.2 meters (0.7 feet) above the predicted astronomical tide elevation (National Ocean Service, 1988). West coast storm surges typically have time scales of 1-3 days, with longer surge episodes possible due to bunching of successive storm events.

Climatic Variation Related to ENSO Events

A positive departure in the annual mean sea level elevations occurs during strong El Nino episodes. As mentioned previously, these meteorological anomalies are characterized by low atmospheric pressures and persistent onshore winds. A review of recorded tide data indicates that six episodes (1914, 1930-1931, 1941, 1957-1959, 1982-1983, and 1997-1998) have occurred since 1905. Further analysis suggests that these events have an average return period of 14 years. During these past ENSO events, water levels have increased above the astronomical tides by about 6-centimeters (2.4-inches) with the effects lasting for 2 to 3 years (Flick, 1998).

An ENSO event also increases the probability that more severe winter storms will be experienced and the likelihood that storm waves could be coincident with times of higher water level. The highest recorded water level in the study area was measured on January 27, 1983. That episode included an estimated 0.24 meters (0.8 feet) of combined storm surge and seasonal sea level rise associated with the climatic variation of the El Nino event.

Global Long-Term Rise in Sea Level

Although the exact magnitude of the future sea level rise is unknown, the future level will depend on the extent of thermal expansion of the ocean water and the amount of melt water from receding continental glaciers and polar ice sheets. The proportion of rise associated with each of these contributions will depend largely upon the magnitude and pattern of global warming, resultant precipitation, glacial response and dynamics, time scale of oceanic mixing, and the stability of the west Antarctic ice sheet (U.S. Army Corps of Engineers, 1991). The U.S. Army Corps of Engineers considers potential relative sea level change in every feasibility study undertaken within the coastal zone. Corps of Engineers policy guidelines for sea level rise is defined in Engineer Circular 1105-2-186 (Dept. of Army 1989) and a Department of Army letter (Dept. of Army 1986).

Historic regional sea level trends based on yearly mean sea level records are published by the National Ocean Service (NOS) (National Ocean Service, 2001). Monthly mean sea level variations are analyzed for 117 stations of the NOS National Water Level Observation Network having between 25 and 146 years of data. Monthly MSL data are used to obtain the average seasonal cycle, the residual time series, and the autoregressive coefficient of the residual with accurate estimates of standard errors. Historic trends in San Diego County, California indicate a positive sea level rise of +2.45 millimeters per year based on water level measurements during the period 1950 to 1999. If past trends were to be projected into the future in San Diego County, a sea level rise of 0.12 meters (0.4 feet) would be expected over the next 50 years.

The long-term consequences of global warming and sea level rise may be the occurrence of more severe ENSO events, more frequent coastal storms, and increased incidents of shoreline erosion and coastal flooding. In addition, an increased sea level will encroach further landward on milder sloping beaches causing an “apparent” shoreline recession.

2.6.2 Waves

Wind, waves, and swell within the project study area are produced by six basic meteorological weather patterns. These include extratropical storm swells in the northern hemisphere (north or northwest swell), wind swells generated by northwest winds in the outer coastal waters (wind swell), westerly (west sea) and southeasterly (southeast sea) local seas, storm swells of tropical storms and hurricanes off the Mexican coast, and southerly swells originating in the southern hemisphere (southerly swell). **Figure 2-13** illustrates these identified weather patterns and their associated wave propagating directions.

Deep water waves that enter within the nearshore coastal area of the study region are altered by offshore island sheltering, refraction, diffraction, and shoaling effects as they propagate towards the shoreline. As waves continue to propagate shoreward, the combined effects of refraction and shoaling must be accounted for when determining the shallow water wave characteristics.

As presented in **Figure 2-14**, San Clemente is directly exposed to ocean swells entering from three main windows. The more severe waves resulting from northwest swell events that are produced by Japanese-Aleutian and Hawaiian storms enter between azimuths 275^{o} and 285^{o}. The Channel Islands (San Miguel, Santa Rosa, Santa Cruz, and Anacapa) and Santa Catalina Island provide the project study area some sheltering from these storms depending on the swell approach direction. The other major exposure window opens to the south, allowing swell from Southern Hemisphere storms, tropical storms and southerly waves from extratropical cyclones to enter between azimuths 158^{o} to 225^{o}. The third exposure window is open to swell propagating towards the site from between Santa Catalina Island and San Clemente Island between azimuths 245^{o} and 259^{o}. Swell approaching through this window occurs less frequently than the other two exposure windows; however, deepwater significant wave heights can range between 11 and 15 feet from this direction.

Wave climatology information is available for the offshore area of San Clemente in the form of direct measurements as part of the Coastal Data Information Program (CDIP). The CDIP shallow-water gage (Station ID 052) most applicable to San Clemente is located approximately 300 m offshore of the San Clemente Pier in 10.2 meters of water. The S_{xy} slope array gage is a directional wave height recorder with a 178-month record during the period between 1983 and 1998 that includes wave height, period and direction. Buoy data consist of a total of four observations per day or every six hours. The height and direction data records are intermittent in that reporting of the data was only available for approximately 141 of the 178 months with one long gap occurring during the period of July 1988 to July 1991, which accounted for the majority of the missing records.

Wave Heights

The histogram of the significant wave heights measured approximately 300 meters offshore of the San Clemente pier is shown in **Figure 2-15**. In addition, the annual maximum wave heights for each year are presented in **Table 2-4**. As is evident from the illustration, the most commonly occurring significant wave height is in the range of 0.80 to 1.00 meter with no measured significant wave heights exceeding 4.0 meters, as the maximum significant wave height was 3.63 meters measured January 18, 1988.

Table 2-4. Annual Maximum Wave Heights, 1983 – 1998

Year	Month/ Day	Significant Wave Height, H_s, m (ft)
1983	December 10	3.10 (10.2)
1984	April 1	1.85 (6.1)
1985	November 29	2.18 (7.2)
1986	February 16	3.56 (11.7)
1987	March 16	2.24 (7.4)
1988	January 18	3.63 (11.9)
1991	November 15	2.06 (6.8)
1992	January 30	2.32 (7.6)
1993	February 18	2.66 (8.7)
1994	February 7	2.00 (6.6)
1995	January 5	3.22 (10.6)
1996	October 26	2.24 (7.4)
1997	December 6	2.31 (7.6)
1998	January 30	2.99 (9.8)

The winter wave climatology can be developed from the measured wave climate previously discussed. Since it is widely recognized that the most severe wave climate occurs during the winter season, it was important to develop the wave climatology based strictly on the winter wave population defined as December through March. The histogram presenting the significant wave height based solely on the winter data is shown in **Figure 2-16**.

Wave Periods

The spectral peak wave period frequencies, presented in **Figure 2-17**, illustrates that the dominant wave periods are in the range between 12 and 14 seconds, with a smaller secondary peak at between 6 and 8 seconds. The two peaks in the distribution demonstrate the dual sea/ swell nature of the wave climate. Shorter period waves are typically associated with local sea conditions; while longer period waves are associated with offshore swell conditions traveling over greater distances.

Wave Directions

The directional separation of the wave data is presented in **Figure 2-18**. The figure illustrates that approximately 91 percent of the waves propagating into the nearshore zone from approximately 300 meters offshore of the San Clemente pier approach from the relatively narrow 20-degree band between the 220° and 240° azimuths, and all other approach directions are minor or negligible. There is a small fraction of waves (0.7 percent) approaching from between 160° and 220°, which are directions considered to be from tropical depressions or southern hemisphere origins. Significantly, the predominate westerly wave direction envelops both local seas and extratropical swell. It is important to note that shoreline normal within the San Clemente project study area is approximately 235° and that shoaling and refraction effects are included in the wave buoy data at the point of observation, approximately 10 meters of water depth.

2.6.3 Currents

The offshore currents, including the California Current, the California Undercurrent, the Davidson Current, and the Southern California Countercurrent (also known as the Southern California Eddy), consist of major large-scale coastal currents, constituting the mean seasonal oceanic circulation with induced tidal and event specific fluctuations on a temporal scale of 3 to 10 days (Hickey, 1979).

The California Current: The California Current is the equatorward flow of water off the coast and is characterized as a wide, sluggish body of water that has relatively low levels of temperature and salinity. Peak currents with a mean speed of approximately 12.5 to 25 centimeters per second occur in summer following several months of persistent northwesterly winds (Schwartzlose and Reid, 1972).

The California Undercurrent: The California Undercurrent is a subsurface northward flow that occurs below the main pycnocline and seaward of the continental shelf. The mean speeds are low, on the order of 5 to 10 centimeters per second (Schwartzlose and Reid, 1972).

The Davidson Current: The Davidson Current is a northward flowing nearshore current that is associated with winter wind patterns north of Point Conception. The current, which has average velocities between 15 and 30 centimeters per second, is typically found off the California coast from mid-November to mid-February, when southerly winds occur along the coast (Schwartzlose and Reid, 1972).

The Southern California Countercurrent: The Southern California Countercurrent is the inshore part of a large semi-permanent eddy rotating cyclonically in the Southern California Bight south of Point Conception. Maximum velocities during the winter months have been observed to be as high as 35 to 40 centimeters per second (Maloney and Chan, 1974).

Alongshore currents are those nearshore currents that travel parallel to the shoreline extending throughout, and slightly seaward of, the surf zone. The alongshore currents in the coastal zone are driven primarily by waves impinging on the shoreline at oblique angles. The rate of alongshore sediment transport varies in proportion to the characteristics of the regional wave climate and the directional predominance. The surf zone alongshore currents within the project area can attain maximum velocities of approximately 1 meter per second. Typically, summer swell conditions produce northerly drifting currents, while large winter storm events from the west and northwest produce southerly alongshore currents. Overall within the project study area, the general magnitude and persistence of the northerly winter storms generally results in a net southerly littoral drift; however, reversals are common during the summer months.

Cross-shore currents exist throughout the study area, particularly at times of increased wave activity. These currents tend to concentrate at creek mouths and shore perpendicular structures, but can occur anywhere along the shoreline in the form of rip currents and return flows of complex circulation. To date, no information is available that quantifies the velocities of these currents within the project area; however, studies have shown that the velocity of rip currents, in general, can exceed 2 meters per second (Dean and Dalrymple, 1999).

2.7 Littoral Processes

The San Clemente project study area resides within the Oceanside Littoral Cell. The Oceanside Littoral Cell extends for approximately 86 kilometers from Dana Point in Orange County to Point La Jolla in San Diego County. The shoreline within this littoral cell displays a wide variety of coastal features including cliffs, headlands, beaches composed of sand and/ or cobbles, rivers, creeks, tidal lagoons and marshes, submarine canyons, man-made shore and bluff protection devices of various kinds, and major harbor structures. The cell is divided into three sub-cells based on natural physiographic units: (1) Dana Point to San Mateo Point, (2) San Mateo Point to Carlsbad Submarine Canyon, and (3) Carlsbad Submarine Canyon to Point La Jolla. The City of San Clemente is located in the northernmost sub-cell.

2.7.1 Sediment Sources

Numerous rivers and small streams discharge sediment into the Oceanside Littoral Cell, as shown in **Figure 2-19**. San Juan Creek and San Mateo Creek are considered to be the major river systems delivering fluvial sediment into the north sub-cell shoreline. Extracts from a listing compiled from the results of various studies (CCSTWS-SD, 1991) are presented in **Table 2-5**, which provide a range of estimates for the beach quality sediment loading carried by fluvial systems within this littoral sub-cell. In addition, this list is supplemented with a recent study for the San Juan Creek watershed. The sediment source due to bluff erosion typically does not directly contribute to the beach area, as the railroad corridor bisects the shoreline and the coastal bluff.

2.7.2 Long Term Shoreline Change

Historical Shoreline Change

Shoreline changes within the Oceanside Littoral Cell were investigated during the CCSTWS-SD (1991) using historical maps, nautical charts, aerial photos, and the results of ground and bathymetric survey efforts. The results of these extensive efforts are shown in **Table 2-6**.

Table 2-5. Sediment Discharge from Rivers and Streams

Previous Studies	River / Stream Discharge Rate m^3/yr (yd^3/yr)		
	San Juan	San Clemente	San Mateo
Drainage Area (hect / mi2)	45,455 (175.5)	5,154 (19.9)	34,188 (132)
Moffatt&Nichol 1977	12,920 (17,000)	10,898 (14,340)	1,702 (2,240)
CCSTWS 84-4 (1984)			24,320 (32,000)
Simons/Li 1985	6,080 (80,00)		12,160 (16,000)
CCSTWS 88-3 (Simons/Li 1988)	15,534 (20,440)	783 (1,030)	3,713 (4,885)
CCSTWS 90-2 (Moffatt&Nichol 1990)	27,360 (36,000)		6,384 (8,400)
COE-LAD 1999	39,749 (52,071)		

Table 2-6. Long Term Shoreline Change Rates in San Clemente Area

	MHHW Shoreline Change Rate, m/yr (ft/yr)			Max Seasonal MHHW Movement, m (ft)	
Location	1940-1960	1960-1980	1980-1989	Summer	Winter
SC 1623	-0.06 (-0.20)	-0.21 (-0.70)	2.16 (7.10)	7.7 (25.4)	-7.9 (-26)
SC 1660	0.00 (0.00)	0.18 (0.60)	-0.61 (-2.00)	5.2 (17)	-10.4 (-34)
SC 1680	0.76 (2.50)	-0.12 (-0.40)	0.43 (1.40)	13.9 (45.5)	-17.5 (-57.4)
SC 1720	0.00 (0.00)	0.00 (0.00)	1.46 (4.80)	9.2 (30)	-8.2 (-27)
DB 1805	-0.58 (-1.90)	2.47 (8.10)	-3.75 (-12.30)	7.6 (25)	-13.9 (-45.6)
DB 1850	-0.18 (-0.60)	2.84 (9.30)		0.8 (2.7)	-21.4 (-70.2)
DB 1895	0.76 (2.50)	-0.12 (-0.40)	-0.15 (-0.50)	7.5 (24.6)	-9.6 (-31.4)
DB 1900	0.00 (0.00)	-0.58 (-1.90)	-3.05 (-10.00)	18.2 (59.8)	-27.9 (-91.4)

This table exemplifies the alongshore variation of the shoreline change within the immediate vicinity of the San Clemente study area, which extends between SC 1623 (State Beach) and SC 1720 (Shorecliffs). There are contradictory trends observed in the data as the data sets are out of phase with adjacent locations; meaning that a transect which is erosional and/or accretional is adjacent to a transect which is accretional and/or erosional over the same time period.

The mean values during the 1940-1960 and 1960-1980 periods are similar in magnitude; however, the mean values during the 1980-1989 period are remarkably higher. Detailed inspection of the data indicates a shoreline that continuously fluctuates between erosional, balanced, or accretional. During the period 1940-1960, the shoreline indicated essentially zero change with a +0.76 m/yr change in the vicinity of SC 1680. During the period 1960-1980, the shoreline vacillated in the alongshore direction between positive and negative. The shoreline change was approximately equal between positive and negative ranging from -0.21 m/yr and +0.18 m/yr. During the period 1980-1989, the shoreline was predominantly positive with accretion rates ranging from +0.43 m/yr to +2.16 m/yr; an erosion value of -0.61 m/yr was recorded at SC 1660.

Current Beach Width Monitoring

The City of San Clemente initiated a beach monitoring program as part of the non-Federal in-kind contributions for this study (Coastal Frontiers, 2002). The general objective of the monitoring program is to document changes in the condition of the shoreline between Dana Point Harbor and San Mateo Point; thereby, providing a basis for evaluating the impacts of natural events and anthropogenic operations. The program includes semi-annual full cross-shore profile surveys at 11 representative sites and bi-monthly beach width measurements at 9 of the 11 profile sites. The full cross-shore profiles were obtained by contract whereas the City of San Clemente lifeguards obtained the bi-monthly beach width measurements.

A description of the transect locations is given in **Table 2-7**. The 11 profile locations include 6 historical locations originally established by the CCSTWS-SD (1991), and 5 locations established specifically for the beach monitoring program in support of this study.

Table 2-7. San Clemente Area Beach Profile Transects

Site #	Transect	Location	Origin
1	DB-1850	N. Doheny State	CCSTWS
2	DB-1805	N. Doheny State Beach	CCSTWS
3	SC-1720	Shorecliffs	CCSTWS
4	SC-1705	Capistrano Trailer Court	Est. Oct. 2001
5	SC-1700	North Beach	Est. Oct. 2001
6	SC-1695	Dije Court	Est. Oct. 2001
7	SC-1680	Linda Lane	CCSTWS
8	SC-1660	T-Street	CCSTWS
9	SC-1645	Lost Winds	Est. Oct. 2001
10	SC1623	San Clemente State Beach	CCSTWS
11	SC-1605	Cottons Point	Est. Oct. 2001

Recent Shoreline Change Rate

The shoreline change rate can be determined from the aggregate of measured data collected in support of the CCSTWS-SD (1991) and the City of San Clemente sponsored beach width monitoring program. This data set is comprised of a compilation of measurements obtained from the 1980's to the present day.

It is noted that this beach width data set is expressed relative to the Mean Sea Level (MSL) contour as opposed to the berm definition that has been adopted for this study. The beach widths are the distance between a fixed point on the backshore and the approximate location of the MSL contour, which is a commonly accepted definition for this level of analysis. The MSL beach width incorporates a portion of the "wet" beach (e.g. the foreshore between the MSL contour and the berm), whereas the berm beach width definition incorporates only the "dry" portion of the beach. Thus the MSL beach widths will be inherently greater than the berm beach widths. Based on a typical beach slope within the study area of 8H:1V, a berm elevation of +6.2 m, and a MSL contour elevation of +1.64 m, the estimated horizontal beach width attributable to this contour elevation difference is approximately 35 meters (114 feet). As a result, the MSL indicates a positive beach width where the beach has been previously defined in many reaches as having zero width (see Section 2.1).

The measured MSL data for the four locations that are historical to the CCSTWS-SD (1991) are presented in **Figure 2-20**. Based on the assumption that the accretion/erosion trend for the berm width would coincide with the trend for the MSL line, the linear regression for each data set representing the trend of the dry berm is developed as shown in the same figure. The slope of the lines represents the mean shoreline trend for each respective data set. The summary of the recent long-term shoreline change rates is presented in **Table 2-8**. The shoreline change data are considered together to obtain representative values for the entire study area. The mean shoreline change rate is –0.20 m/yr (-0.7 ft/yr), the maximum erosion rate is –0.61 m/yr (-2.0 ft/yr) and the maximum accretion rate is +0.38 m/yr (+1.24 ft/yr).

Table 2-8. Summary of Recent Long Term Shoreline Change Rates

Location	Erosion Rate, m/yr (ft/yr)
SC 1720, Shorecliffs	+0.38 (+1.24)
SC 1680, Linda Lane	-0.24 (-0.79)
SC 1660, T – Street	-0.61 (-2.00)
SC 1623, State Beach	-0.33 (-1.09)

There are contradictory trends observed in the data as the Shorecliffs data set is out of phase with the other three. The three data sets around the pier are consistent in trend and phase. The data sets indicate consistent erosion and accretion trends at the same time; however, the mean values are similar in magnitude. The data set at Shorecliffs is nearly opposite in behavior. The beach is erosional and/or accretional when the others are accretional and/or erosional.

2.7.3 Short-Term Storm Induced Beach Change

Short-term shoreline erosion data have been collected within the U.S. Army Corps of Engineers, Los Angeles District as part of the Orange County Beach Erosion Control Project (Surfside-Sunset). This data set represents a collection of linear beach widths collected at 26 locations over a period of 33 years and is used in the present analysis to estimate shoreline response under storm conditions for the San Clemente project study area.

The data set collected at 26 locations represents various beach and shoreline conditions. The measured shoreline response data was correlated to ten known significant storms to estimate the degree of short-term storm-induced erosion under various intensities of storm events. However, the aforementioned study area is morphologically very different from the San Clemente study area. The northern Orange County area primarily consists of wide sandy beaches and a full sand profile. This is compared to the San Clemente study area that has been shown to be primarily a hard bottom area with a thin lens of sand along the shoreline. Thus the San Clemente area has inherently less beach width to exchange in the cross-shore direction due to storm induced impacts. Therefore, the raw data collected from northern Orange County was modified to more realistically reflect the expected San Clemente shoreline response. The results of this analysis are shown in **Figure 2-21**.

2.7.4 Cross-Shore Profiles

Cross-shore profiles are compiled from the LIDAR topographic data and bathymetric measured data for Reaches 1 through 8 and are shown in **Appendix C1**. Profiles from Reach 6 in the vicinity of the San Clemente Pier and Reach 7 in the vicinity of Mariposa Point may be considered to be representative of a non-armored and armored shoreline, respectively, throughout the study area. As such, the characteristic profiles for a shoreline segment both with and without a protective railroad corridor revetment are presented in **Figures 2-22 and 2-23**, respectively. Only the portion of the profile from the bluff to the waterline is shown in order to better illustrate the detail of the foreshore and backshore regions. The profile centerline is established at the seaward rail of the SCRRA railroad. The pier area beach profile indicates a typical berm elevation of +5.2 meters (+17 feet), a typical foreshore slope of 8H:1V to 10H:1V, an offshore slope of 110H:1V, and a railroad elevation at approximately +6.4 meters (+21 feet), MLLW. The Mariposa Point area profile indicates a mean revetment crest elevation at +6.9 meters (+23 feet), MLLW, typical revetment slope of 1H:1V, toe elevation at approximately 0.0 meters, MLLW, an offshore slope of 110H:1V, and a railroad elevation at approximately +6.4 meters (+21 feet), MLLW.

2.7.5 Foreshore Slopes

Foreshore slope data was obtained by the City of San Clemente lifeguards, who obtained direct measurements of the foreshore slope as part of the aforementioned beach width monitoring program. Approximately 21 measurements were obtained 2 to 3 times each month for a 12 month duration during the period of November 2001 to November 2002 at nine selected locations throughout the study area. The slope was measured in degrees from horizontal and converted to the slope cotangent. Assuming that the year of data collection adequately represents the future annual project period, this data set may be considered to represent the typical annual variation of foreshore slope values across the study area. **Figure 2-24** presents the foreshore slope measurement histogram for the entire year of the data collection efforts.

2.7.6 Profile Sediment Thickness

Data collected for the Sand Thickness Survey Report (USACE-LAD, 1988) allows estimation of the available sediment supply and consequently any potential limits to erosion. The work performed in this study consisted of jet probing activities along various profiles to determine the available sediment thickness. Three profiles in the San Clemente area were jet probed including SC-1623 (San Clemente State Beach), SC-1660 (T-Street) and SC-1720 (Capistrano Shores). The survey results indicate that the sediment thickness is relatively thin throughout the project nearshore area in depths from – 3 to –9 meters, MLLW and; conversely, that the associated hard bedrock substrate is relatively high relative to the shoreline position. The results of this analysis are presented in **Table 2-9**.

Table 2-9. Summary of Profile Sediment Thickness

Range Line	No.	Range	Elevation (MLLW)	Sand Thicknes	Bedrock Elevation (m, MLLW)
SC-1623	1	21.1 m (69.3 ft)	4.1 m (13.5 ft)	3.1 m (10.1ft)	+1.0
SC-1623	2	34.6 m (113.5 ft)	3.4 m (11.1 ft)	3.2 m (10.5ft)	+0.2
SC-1623	3	51.7 m (169.6 ft)	2.1 m (6.9 ft)	2.4 m (7.7 ft)	-0.3
SC-1623	4	194.2 m (636.8 ft)	-3.5 m (-11.4 ft)	0.1 m (0.4 ft)	-3.6
SC-1623	5	266.1 m (872.8 ft)	-6.0 m (-19.6 ft)	0.3 m (0.9 ft)	-6.3
SC-1623	6	504.2 m (1653.8 ft)	-9.3 m (-30.5 ft)	0.6 m (1.8 ft)	-9.9
SC-1660	1	11.5 m (37.6 ft)	5.0 m (16.3 ft)	4.5 m (14.8ft)	+0.5
SC-1660	2	23.5 m (77.2 ft)	3.1 m (10.2 ft)	3.4 m (11.2ft)	-0.3
SC-1660	3	42.9 m (140.6 ft)	1.5 m (4.8 ft)	2.1 m (6.9 ft)	-0.6
SC-1660	4	232.8 m (763.5 ft)	-3.1 m (-10.1 ft)	0.1 m (0.4 ft)	-3.2
SC-1660	5	462.4 m (1516.5 ft)	-6.5 m (-21.3 ft)	0.7 m (2.2 ft)	-7.2
SC-1660	6	673.6 m (2209.5 ft)	-9.0 m (-29.6 ft)	2.7 m (8.8 ft)	-11.7
SC-1720	1	10.9 m (35.9 ft)	4.7 m (15.4 ft)	4.5 m (14.9ft)	+0.2
SC-1720	2	24.8 m (81.4 ft)	2.7 m (8.7 ft)	2.9 m (9.6 ft)	-0.2
SC-1720	3	46.5 m (152.6 ft)	0.6 m (1.9 ft)	1.0 m (3.3 ft)	-0.4
SC-1720	4	165.2 m (541.9 ft)	-2.5 m (-8.1 ft)	0.0 m (0.0 ft)	-2.5
SC-1720	5	494.8 m (1622.9 ft)	-6.7 m (-21.9 ft)	0.2 m (0.5 ft)	-6.9
SC-1720	6	879.5 m (2884.9 ft)	-8.6 m (-28.3 ft)	0.2 m (0.7 ft)	-8.8

In addition, the measurement results identified cobbles, boulders, and other hard substrate at various depths along the profile. The observations include “some pebbles scattered on beach surface and some boulders visible at backshore” and “offshore sand-stone outcrops with local bottom relief of 1 ft”. This information is consistent with 2002 geologic information collected during geophysical studies conducted as part of this study, and reported in the Geotechnical Appendix.

2.7.7 Sediment Budget

A sediment budget for without-project conditions has been developed based on the CCSTWS-SD (1991). Development of the sediment budget involves defining the sediment sources, sinks, losses; transport modes; erosion and accretion rates; and balancing the resultant budget. Some additional information was obtained during this study to enhance the previously developed sediment estimates. Compilation of the sediment budget specific to San Clemente is described hereinafter and is further described in the CCSTWS-SD (USACE-LAD,1991).

The analysis of the budget of sediment for this cell has been carried out for three time periods: (1) the period from 1900 – 1938, (2) a mild, uniform weather period from 1960 – 1978, and (3) a period of more variable wave climate covered by the CCSTWS-SD studies from 1983 – 1990. The 1900 – 1938 “natural” budget permits an uncluttered look at the cell as it predates construction of dams and Oceanside Harbor, although it necessarily draws on some findings from later studies. The mild, uniform period from 1960-1978 was selected to evaluate the effects of Oceanside Harbor at a time when the wave climate was consistent from year to year and less variable than the present wave climate. The last period of more variable wave climate extending from 1983 – 1990 emphasizes the change in wave climate from one that gave a consistent, strong southerly littoral transport to one that yields a more variable transport with a net northerly component in some years. The resultant sediment budget for the three time periods is shown in **Table 2-10**.

Table 2-10. Sediment Budget for Dana Point Subcell (Dana Point to San Mateo Point)

	1900-1938		1960-1978		1983-1990	
	Input	Output	Input	Output	Input	Output
Q_l	0	130	0	130	0	35
Q_n	0	15	0	15	0	5
$Q_{b,o}$	130	45	90	45	45	0
Q_a	0	0	90	0	0	0
$Q_{r,s}$	65	0	45	0	0	0
Total	+195	-190	+225	-190	+45	-40
Net $(\partial V'/\partial t)$	+5		+35		+5	
$\partial X/\partial t$ (m/yr)	+0.03		+0.18		+0.03	

Source: USACE-LAD, 1991
Notes:
Q = total sand transport rate into or out of cell in1,000 m^3/yr
a = artificial nourishment, bypassing, dredging, etc
b = blufflands erosion; includes seacliffs, gullies, coastal terrace, slumps, etc as distinct from rivers
l = longshore transport of sand in and near the surfzone
n = nearshore transport along the coast, outside the surfzone
o = onshore/offshore transport at the base of the shorerise
r = river yield to the coast
s = lost to submarine canyons
$\partial V'/\partial t$ = sand volume change rate, m^3/yr
$\partial X/\partial t$ = shoreline change rate, m/yr

The resultant sediment budget indicates the shoreline is essentially in balance between erosion and accretion. The budget is considered to be in balance when the shoreline change rate $\partial X/\partial t$, computed from the volume flux is less than 0.03 m/yr (0.1 ft/yr). The shoreline indicates a balance in the "natural" time period and the most recent variable wave climate time period. The net volume flux indicates the budget is very slightly accretional during the uniform wave climate period.

2.8 Environmental Resources

2.8.1 Biological Resources

The biological resources located within the San Clemente project study area are presented in **Figure 2-25**. The predominant intertidal habitat along San Clemente's shoreline is sandy beach, although some rocky outcrops that extend from mid-beach to the low intertidal are present at Mariposa Point (Reach 7), north of San Clemente Pier. Beyond the surf zone, the seafloor is a mosaic of sand and low-to-high relief patch reef. Some pinnacles of the reef are visible in the nearshore zone at low tide while two prominent offshore pinnacles break the surface offshore of Mariposa Point and south of the San Clemente Pier. Other reef habitats are located south of the pier offshore of T-Street that extend west, and then north around the end of the San Clemente pier, and secondly, offshore San Mateo Point (Reach 1). Sensitive biological resources are found within a broad band of the region between San Clemente and Oceanside that have a potential to be affected by beach stabilization and/ or protection projects. However, there are a few species that may use the nearshore zone for foraging, namely, the California least tern (*Sterna antillarum browni*) and the California brown pelican (*Pelecanus occidentalis occidentalis*)

2.8.2 Marine Habitats

Three types of vegetated habitats, nearshore kelp and macroalgae, surfgrass beds, and offshore kelp beds, are present in the intertidal to subtidal habitats off San Clemente. Although the predominant intertidal habitat along San Clemente's shoreline is sandy beach, an area of rocky intertidal is present at Mariposa Point (Reach 7) approximately 975 meters (3,200 feet) north of the San Clemente Pier. Boulders and rocky outcroppings in this area support a variety of algal species. In the high intertidal, boulders support filamentous green algae (*Enteromorpha* spp.). The mid to low intertidal algae composition is dominated by encrusting red algae (*Lithophyllum* spp., *Lithothamnion* spp.), encrusting brown algae (*Pseudolithoderma* spp.), and coralline algae (*Corallina* spp.). Filamentous red algae, consisting of several species, and green algae (*Enteromorpha* spp. and *Ulva* spp.) also occur in these zones. Larger brown algae species colonize the base of the intertidal reef throughout the area, including palm kelp (*Eisenia aborea*) and feather boa kelp (*Egregia menziesii*). Surfgrass (*Phyllospadix* spp.) is present in the low intertidal beginning approximately 91.4 meters (300 feet) offshore of the sandy beach. Surfgrass is present throughout the low intertidal platform of Mariposa Point. Other offshore rocks are found approximately 1,951 meters (6,400 feet) (Reach 4) south of the San Clemente Pier.

The shallow subtidal zone for much of the project area is a mixture of sand and boulder, with occasional outcrops of exposed shale bedrock. The subtidal areas between North Beach and Mariposa Point and offshore of Linda Lane, Mariposa Point, and T Street support filamentous red algae, coralline algae, crustose coralline algae, feather boa kelp, palm kelp, and surfgrass. Historically, offshore kelp beds, dominated by giant kelp with an understory of feather boa kelp and palm kelp, have been prevalent along this section of coastline, but within the last several years, the canopy has experienced a sharp decline (Coastal Resources Management, 2000). During surveys in June 2000, Coastal Resources Management (CRM) found low density kelp beds with little or no surface canopy approximately 610 meters (2,000 feet) off of Mariposa Point and 1,219 meters (4,000 feet) from North Beach at depths between –7 and –8.5 meters (-23 and –28 feet) MLLW. Another bed was observed 198 meters (650 feet) off of San Clemente Pier (T Street) at a depth of 4.9 meters (16 feet) in October 1999. This patch was not observed during the June 2000 survey (CRM, 2000). Much of the kelp observed in June 2000 was ragged and covered with fouling ectoprocts (*Bryozoa*); however, newly settled recruit plants were also present (CRM, 2000)

Soft Bottom Communities

Common benthic invertebrates observed on southern California sandy beaches between the low and high tide marks include sand crabs (*Emerita analoga*), beach hoppers (*Orchestoidea* spp.), burrowing polychaete worms, amphipods, isopods, and clams.

The offshore benthos in the shallow subtidal are expected to be similar to species that are common to north San Diego County located approximately 40 kilometers (25 miles) from the project area. Subtidal invertebrates commonly observed in San Diego County that are likely to be found in the project area include tube-dwelling polychaete worms (e.g. *Diopatra* spp., *Loimia medusa*, *Pista pacifica*), sand dollar (*Dendraster excentricus*), crabs (*Heterocrypta occidentalis*, *Portunis xantusii*, *Randallia ornata*), hermit crabs (*Pagurus* spp., *Pagurites* spp.), marine snails (*Nassarius fossatus*, *Olivella biplicata*, *Polinices* spp.), clams (*Ensis* spp.), armored sea star (*Astropecten armatus*), tube anemones (*Harenactis attenuata*, *Zaolutus actius*), sea pens (*Stylatula elongata*), and sea pansies (*Renilla kollikeri*) (MEC, 2002; Thompson et al, 1993).

The number of species and density of bottom dwelling macroinvertebrates is expected to be low in the area of potential offshore borrow sites, which will most likely be within the inner shelf zone. Infaunal abundance and diversity is generally low in the inner shelf compared to the middle and outer shelf because the inner shelf zone is regularly disrupted by wave activity and oceanic swell (SANDAG, 2000). Polychaete worms and/or small, mobile crustaceans typically dominate the inner to middle shelf infaunal communities of the SCB (SANDAG, 2000).

Fish species that occur within the study area are expected to be similar to those found in San Diego County. Fish commonly found over sandy subtidal habitat (less than 9 meters or 30 feet) off of San Diego County beaches include California halibut (*Paralichthys californicus*), speckled sanddabs (*Citharichthys stigmaeus*), barred surfperch (*Amphistichus argenteus*), white croaker (*Genyonemus lineatus*), bat ray (*Myliobatus californica*), and shovelnose guitarfish (*Rhinobatos productus*) (MEC 2002, SANDAG 2000). Northern anchovy (*Engraulis mordax*), jack mackerel (*Trachurus symmetricus*), Pacific bonito (*Sarda chiliensis*), and topsmelt (*Athernops affinis*) are commonly encountered in the water column just beyond the surfzone (MEC, 2002; SANDAG, 2000). Flatfish, including speckled sanddab, horneyhead turbot (*Pleuronichthys verticalis*), and fantail sole (*Xystreurys liolepis*), are more common at deeper inner shelf depths ranging from –10 to –24 meters (-30 to –80 feet) MLLW (MEC, 2002).

The sandy beach area in proximity of Linda Lane is a potential grunion spawning area, although recent successful spawning has not been reported (CRM, 2000). California grunion (*Leuresthes tenuis*) are fish that are associated with many beaches in southern California. Grunion lay their eggs in the wet beach sands during the highest spring tides between late February or early March, to as late as early September (Walker, 1952). The eggs incubate a few inches deep in the sand and hatch approximately 10 days later during the next series of high tides (Chambers Group, Inc., 2002). San Clemente beaches are not actively used by grunion as a spawning site based on interviews with San Clemente lifeguards working the beaches for the last 30 years (Lynn Hughes, City of San Clemente, personal communication, August 19, 2000).

<u>*Hard Substrate Communities*</u>

The area at Mariposa Point consists of sensitive rocky intertidal habitat, which supports a relatively diverse invertebrate community on individual boulders as well as on the surfaces of the low-lying platform reefs (CRM, 2000). The high intertidal or splash zone is characterized by barnacles (*Cthamalus* spp.), limpets (*Lottia* spp., *Collisella* spp.), and periwinkle snails (*Littorina* spp.) (MEC, 2002). The California mussel (*Mytilus californianus*), aggregating anemone (*Anthopleura elegantissima*), giant green anemome (*A. xanthogrammica*), chitons (*Mopalia muscosa* and *Nuttallina californica*), barnacles (*Balanus* spp.), hermit crabs, and snails (*Acanthina* spp.) are commonly observed throughout the middle and low intertidal zones (CRM, 2000; MEC, 2002). Although not common, the reef-building sandcastle tube worm (*Phragmatopoma californica*) was also found around the base of several boulders in the middle intertidal zone (CRM, 2000). The low intertidal zone and the adjoining subtidal rocky habitat, including the apex of the offshore reefs, support a diverse assemblage of invertebrate species. Typical reef organisms observed during the June 2000 survey conducted by CRM included mussels (*Mytilus californianus* and *M. edulis*) gorgonians (*Muricea californica* and *M. fructicosa*), keyhole limpet (*Megathura crenulata*), purple and red sea urchin (*Strongylocentrotus purpuratus* and *S. franciscanus*), California sea cucumber (*Parastichopus californicus*), Kellet's whelk (*Kelletia kelletii*), and sea stars (*Pisaster brevispinus* and *P. giganteus*). Other species expected to occur include the California sea hare (*Aplysia californica*), as well as various crabs and marine snails (MEC, 2002).

Up to ten species of fish utilize the low to minus tidal zones of rocky intertidal habitats in the SCB (MEC, 2002). Wooly sculpin (*Clinocottus analis*) is one of the more commonly encountered fish species in tidepools, but juvenile opaleye (*Girella nigricans*), rockpool blenny (*Hypsoblennius gilberti*), spotted kelpfish (*Gibbonsia elegans*), and California clingfish (*Gobiesox rhessodon*) may also be present (Cross and Allen, 1993).

The June 2000 survey also identified spotted sand bass (*Paralabrax maculofasciatus*), kelp bass (*P. clathratus*), senorita (*Oxyjulius californicus*), bat ray, and black surfperch (*Embiotoca jacksoni*). Other fish that are commonly associated with nearshore reef habitats with developed stands of perennial vegetation above one meter (3 feet) in height may also be present within the project area, including barred sand bass (*P. nebulifer*); shiner, walleye, and dwarf surfperches (*Embiotocidae*); California sheephead (*Semicossyphus pulcher*); garibaldi (*Hypsypops rubicundus*); jack mackerel (*Trachurus symmetricus*); giant kelpfish (*Heterostichus rostratus*); painted greenling (*Oxylebius *pictus*); and halfmoon (*Medialuna californiensis*) (MEC, 2002; Thomson et al., 1993). The dominant fish species in the offshore kelp beds, approximately 650 meters (2,000 feet) offshore of Mariposa Point (Washrock Reef) and 1,220 meters (4,000 feet) from North Beach at depths between –7 to –8.5 meters (-23 to –28 feet) MLLW, are expected to be surfperch (*Embiotocidae*); rockfish (*Sebastes* spp.); and wrasses (*Labridae*) (e.g. sheephead, senorita, and rock wrasse (*Halichoeres semicinctus*)).

<u>*Birds*</u>

A diverse variety of resident and migratory seabirds and shorebirds are commonly observed along southern California beaches and offshore waters. Seabirds such as pelicans, terns, and cormorants forage for fish in the Nearshore Ocean. Sandy upper tidal beaches are utilized by gulls and shorebirds as roosts. Gulls feed on fish and invertebrates, particularly near the edge of the kelp canopy. Shorebirds probe for invertebrates in the damp sands of the middle and low intertidal zones, and some species also forage for small fish and invertebrates in the rocky intertidal. Kelp and surfgrass that have washed ashore harbor invertebrates and, thus provide good foraging areas for gulls and shorebirds.

The seabirds that are most commonly observed along the beaches and ocean waters offshore of Orange and San Diego Counties include Heerman's gull (*Larus heermanni*), ringed-billed gull (*L. delawarensis*), western gull (*L. occidentalis*), California brown pelican (*Pelecanus occidentalis californicus*), surf scoter (*Melinita perspicillata*), terns (*Sterna* spp.), grebes (*Podicipedidae* spp.), double-crested (*Phalacrocorax auritus*), Brandt's (*P. pencillatus*), and pelagic (*P. pelagicus*) cormorant (Chambers Group, 2002; MEC, 2002). Commonly observed shorebirds include black turnstone (*Arenaria melanocephala*), marbled godwit (*Limosa fedoa*), sanderling (*Calidris alba*), whimbrel (*Numenius phaeopus*), willet (*Catoptrophorus semipalmatus*), dunlin (*Calidris alpina*), western sandpiper (*Calidris mauri*), and least sandpiper (*Calidris minutilla*) (Chambers Group, 2002; McConnaughey and Mcconnaughey, 1988; MEC, 2002).

<u>*Marine Mammals (Non-Endangered)*</u>

The marine mammals that occur in the Southern California Bight have been described in detail in previous studies and environmental documents (e.g. Bonnell et al., 1981; 1983; Bonnell and Dailey, 1993; Dohl et al., 1982; 1983; ADL, 1984; Barlow, 1995; Barlow, et al., 1995, 1997; Barlow and Geroodette, 1996; Koski et al., 1998; FWS, 2000; Delong and Melin, 2000; Stewart and Yochem, 2000). Although as many as 34 species of marine mammals inhabit or visit the Southern California Bight, including 6 species of pinnipeds (seals and sea lions), 27 species of cetaceans (whales, porpoises, and dolphins), and the sea otter, only about 4 species are expected to occur in the nearshore waters of the study area off San Clemente on a regular basis. These include 2 pinnipeds, 1 whale, 1 porpoise, and 1 dolphin. Other species may also occasionally occur in the study area on an irregular basis.

2.8.3 Threatened and Endangered Species

In response to requests to the NMFS and the FWS for a list of threatened and/ or endangered species present in the vicinity of the proposed project study area, NMFS indicated that no threatened and endangered species under their jurisdiction are expected to occur in the study area and FWS indicated that two threatened and endangered fish; the tidewater goby (*Eucyclogobius newberryi*) and the southern steelhead (*Oncorhynchus mykiss*); three threatened and endangered birds, the California brown pelican (*Pelecanus occidentalis*), the California least tern (*Sterna antillarum browni*), and the western snowy plover (*Charadrius alexandrinus nivosu*); and one mammal, the Pacific pocket mouse (*Perognathus longimembris pacificus*) may occur in the study area. A detailed description of each of these threatened and endangered species is presented in the Environmental Appendix.

2.8.4 Water Quality

Water quality is typically characterized by salinity, pH, temperature, clarity, and dissolved oxygen (DO). **Table 2-11** characterizes the overall water quality parameters for the project site.

Table 2-11. Water Quality Characteristics

Parameter	Range
Salinity (ppt)	33 to 34
Surface Temperature (F)	57.2 to 67.1
PH	7.4 to 7.6
Clarity (feet)	13 to 15
D.O. (mg/L)	6.5 to 10

- Water temperatures range from approximately 14°C (winter minimum) to 22°C (summer maximum). During the summer, surface water temperatures are up to 10°C warmer than those in deeper waters.

- Near shore salinity is generally uniform, from approximately 33 to 34 ppt. Seasonally, the near-surface salinity can decrease near the Prima Deshecha & Segunda Deshecha Watershed following storm-related discharges of freshwater and/ or (historically) intermittent discharges of sewage into the river.

- Dissolved oxygen concentrations typically lie between approximately 6.5 and 10 milligrams per liter (mg/L), but may drop below approximately 5 mg/L at depths of 60 meters.

Light transmittance (indicating water clarity) has been measured at approximately 4 to 4.5 meters (13 to 15 feet). Some reduction was associated with storm activity, particularly in shallower, near shore waters. Both light and nutrients are needed to support photosynthesis by attached and planktonic plants.

Nutrient concentrations are expected to be similar to those elsewhere in the Southern California Bight: Nitrates at approximately 5 to 200 nanomoles per liter; phosphates at approximately 100 to 500 nanomoles per liter; and ammonium at approximately 300 nanomoles per liter. Discharges from the Prima Deshecha & Segunda Deshecha likely represent an important seasonal source of nutrients to nearshore waters. Upwelling events also contribute nutrients to surface waters.

Historically, bacterial levels in nearshore surface waters of the study area have been affected by episodic discharges of domestic sewage carried by the Prima Deshecha & Segunda Deshecha and flowing north along the coast. These releases have resulted in beach postings of health warning signs where the ocean and/or bay water failed to meet biological standards.

2.8.5 Sediment Quality

According to data published by U.S. Department of Agriculture, Soil Survey, a description of sediment in the study area including beaches, riverwash and tidal flats is presented in **Table 2-12**, with the exception of the area between Dana Point and Dana Cove (within Dana Point Harbor).

Table 2-12. Soils of the San Clemente Project Area

Description
Beaches consist of sandy, gravelly, or cobble coastal shores that are washed and rewashed by tidal and wave action. These areas may be partly covered with water during high tides or stormy periods. They support little or no vegetation and have no agricultural value. Some are excellent recreational areas. Runoff is very slow, and the erosion hazard is high. Present land use is recreation and urban development. Tidal flats are nearly level, poorly drained, stratified clayey to sandy deposits that are adjacent to bays and lagoons along the coast and are high in salts. Both are subject to tidal action and may be at least partly inundated by high tides. Riverwash consists of sandy, gravelly, cobble, stony and bouldery deposits along stream channels that are subject to stream overflow.

2.8.6 Ambient Noise and Air Quality

Dominant noise sources include waves, beach recreation activities, and vehicle noise on adjacent roads. The sound of wave action will vary with factors including wave height, period, frequency, angle of attack, season, and wind conditions. Background noise levels are generally low, due to the limited traffic and residential nature of the area. Two major sources of noise exist in the San Clemente Beach region: rotorcraft air operation training at Camp Pendleton, south of the southernmost region of the San Clemente project study area, occurring periodically throughout the year; and temporary construction activities. Noise levels occasionally impair normal conversation.

The most important climatic and meteorological characteristics influencing air quality in the study area are persistent temperature inversions, predominance of onshore winds in Orange County, mountain ridge and valley topography, and prevalent sunlight. Air quality is evaluated by measuring ambient concentrations of pollutants that are known to have deleterious effects. The degree of air quality degradation is then compared to ambient air quality standards (AAQS). Annual ambient air quality monitoring has been conducted at two locations (El Toro and Costa Mesa) approximately 20 miles north of the project area between 1992 and 1997. Detailed monitoring results can be found in the Environmental Appendix. The high frequency of southwest to northwest sea breezes usually occur during the daytime for most of the year and transports air pollutants away from the coast toward the interior regions in the afternoon hours. As a result, air quality conditions along the coast, such as Newport Bay, are typically better than the conditions presented for the interior Costa Mesa and El Toro Monitoring Stations.

In addition to criteria pollutants, other regulated pollutants include toxic air contaminants (TACs), which are suspected or known to cause cancer, genetic mutations, birth defects, or other serious illnesses in exposed people. (The TACs are not regulated by the NAAQS or CAAQS, but are addressed by the National Emission Standards for Hazardous Air Pollutants [NESHAPs] and Title III of the 1990 Clean Air Act Amendments). Generally, TACs behave in the atmosphere in the same way as inert pollutants. The level of emissions at the source determines the concentrations of both inert and toxic pollutants. Thus, impacts from toxic pollutant emissions tend to be site specific and their intensity is subject to constantly changing meteorological conditions. The worst meteorological conditions that affect short-term impacts (low wind speed, highly stable air mass, and constant wind direction) occur relatively infrequently.

2.8.7 Cultural Resources

Named after one of the offshore southern Channel Islands, San Clemente Island, the city was founded by a former mayor of Seattle, Ole Hanson, in 1925 (Brock 1985). San Clemente was among the first master planned communities built from totally open land in the United States. Before erecting a single structure on the rolling coastal hills, Ole Hanson laid out an expansive plan based on the Spanish Colonial architectural style including restaurants, a clubhouse, residences, public parks, a public pool, a fishing pier, and even equestrian trails. Hanson's residential community, promoted as "The Spanish Village," featured wide, meandering streets that conformed to the contours of the hills, houses situated to provide an ocean view, and mandatory white stucco exteriors and red tile roofs for every building. San Clemente was incorporated in 1928, and grew rapidly until the Depression, when development halted. The growth rate picked up again during the 1950s, and was later boosted by construction of the San Diego Freeway.

Today, the Spanish Village by the Sea is more heterogeneous than Hanson had envisioned, but historic homeowners and current planning and development all reflect increasing esteem for his red-roofed, white-walled Spanish architecture dream. Historic homeowners must abide by city codes that protect the aesthetic spirit and style of early San Clemente.

A records and literature search was completed at the South Central Coastal Information Center at California State University, Fullerton to determine if prehistoric or historic sites had been previously recorded within the project area. While no sites have been recorded within the project area, three shell middens and an isolate have been recorded adjacent to the project's eastern boundary (**Table 2-13**). In addition, the Historic Resources Inventory (HRI), which includes the National Register (NR), California Register, State Historic Landmarks, Points of Historic Interest and all properties evaluated for the NR, identified two properties located in the project vicinity: Casa Romantica (located in Reach 6, added to the NR in 1991; No. 91001900) and San Clemente Beach Club (located in Reach 9, added to the NR in 1981; No. 81000164).

No recorded archaeological sites or historic properties have been recorded within the project area.

Table 2-13. Summary of Recorded Archaeological Sites

Site No.	Description	Source & Date
CA-Ora-101	Shell Midden	Smethe 1954
CA-Ora-102	Shell Midden, village site, manos	Waldeck 1948
CA-Ora-103	Shell Midden, hammerstone, manos	Waldeck 1948
Update	Bulldozer removed most of site	Smith 1953
30-100074	Basalt dentidular flake (Isolate)	Naxib 1996

The project area has been extensively disturbed by urban development. The above listed archaeological and historical sites will not be impacted by the proposed project. Because the southern California coast is rich with cultural history, discovery of buried sites is always a possibility. If cultural resources are located, the Corps must be notified immediately.

2.8.8 Aesthetics

The City of San Clemente General Plan Natural and Historic/Cultural Resources Element promotes development of programs "that will preserve and maintain the physical features of the coastal zone including bluffs, canyons, and beaches." Views to the west of the entire San Clemente shoreline region are of the Pacific Ocean. With the exceptions of Pacific Ocean views, the central portion, and a southern area along the San Clemente shoreline region of the project area, the view shed is generally disturbed partly due to residential development. Conversely, the central portion of the project area includes agricultural areas, while the southern area has a portion that is vacant and generally devoid of human development and consists mainly of natural views.

2.9 Economic Conditions

2.9.1 Historic Development

The City of San Clemente founded by Ole Hanson consisted of 2,000 acres between the state highway and the ocean, located 66 miles from Los Angeles and 66 miles from San Diego. Despite much skeptism from realtors and other developers, Hanson moved forward and laid out his planned community using airplane photographs, and in December 1925, he began selling lots. Over a six month period, 1,200 lots were sold, and by November 1926 the building program was calling for completing 16 buildings every week. As part of his development program, Hanson deeded to the residents of the village, 3,000 feet of beach, the Community Clubhouse, beach Club, Fishing Pier, and golf course. In three and a half years, San Clemente had grown to the point where it was generally conceded to be the wealthiest city per capita in America. In 1928, the City of San Clemente was incorporated and received title to the water system, the beach club, the pier, 3,000 feet of beach, 17 miles of riding trails, the community center, the school and parks for $1.

2.9.2 Socio-economic Profile

2.9.2.1 Population

The majority or 60-percent of Californians live in Southern California. The 2001 Census reported that Orange County has a population of 2,890,444 with San Clemente reporting a population of 60,701. The city of San Clemente has experienced a net increase of over 8,836 people since 1990, an increase of 21.5-percent. **Table 2-14** shows the comparative population data. The median age of the population of San Clemente is 38 years. Population is projected to grow to 62,853 for the City of San Clemente by the year 2025. Orange County median age is 31, and the median age for California is 33.6.

Table 2-14. Comparative Population Data (1980-2025)

Area	1980	1990	2000	2025	Percent Change (%)
San Clemente	27,235	41,100	49,936	62,853	7.70
Orange County	1,932,705	2,410,556	2,846,289	3,416,037	15.40
California	23,667,764	29,760,021	33,871,648	43,01,763	13.80
United States	226,549,000	248,709,873	281,421,906	344,683,537	13.20

2.9.2.2 Employment.

Table 2-15 indicates the predominant sectors of employment for residents of the study area, according to the Profile of Selected Economic Characteristics: 2000, recently published by the U.S. Census Bureau. As shown in the table, the sales and office occupations are important in the region associated with the study area. Also, important sectors include: management and professional services, production and transportation occupations, service occupations, and construction and maintenance. In Orange County, the unemployment rate in 2002 was 4.1% up from 3.0% in 2001. The city of San Clemente has a rate of 2.7% much lower than the county rate and California, which is 6.7%.

Table 2-15. Employment

Industry	San Clemente	Orange County	California
Industry Total	24,654	1,410,700	14,718,928
Farming & Mining	81	8,200	282,717
Construction	2,081	79,200	915,023
Manufacturing	2,482	190,000	1,930,141
Wholesale & Retail Trade	6,373	192,400	2,237,552
Transportation & Warehousing & Utilities	2,032	262,300	689,387
Finance, Insurance & Real Estate	2,035	110,600	1,016,916
Service	13,430	568,000	7,647,192

2.9.2.3 Income

Table 2-16 summarizes pertinent information regarding income and effective buying power by household in the study area. Approximately, 86-percent of the people employed were private wage and salary workers. In 2001, 10 percent of people were below the poverty line. Eighty-eight percent of the households received earnings and 18 percent received retirement income other than Social Security. Twenty-one percent of the households received Social Security. The average income from Social Security was $10,523. The per capita income and median household income, in the study area are higher than figures for the county and substantially higher compared to the state.

Table 2-16. Income Level By Household

Income Distribution	San Clemente	Orange County	California
Total Households	19,457	936,154	11,512,020
Less than $15,000	1,403	81,576	1,615,869
$15,000-$24,000	1,416	81,207	1,318,246
$25,000-$34,999	1,921	92,352	1,315,085
$35,000-$49,000	2,710	137,223	1,745,961
$50,000-$74,000	3,836	193,379	2,202,873
$75,000 or more	8,171	350,417	3,313,986
Median Household Income	$63,507	$58,820	$47,493
Per Capita Income	$34,169	$25,826	$22,711

2.9.3 Land Use

San Clemente is comprised of 46.1 square kilometers. The beach characteristics for each discritized reach are described in Sections 2-1. Beach facilities are primarily located in reaches 6 and 7, provide basic services, and enhance the recreation experience for users at San Clemente Beach. **Table 2-17** shows the square footage and depreciated replacement value of public buildings that are vulnerable to wave attack and erosion of the shoreline. The building costs for the structures along the shoreline are significantly higher than inland, due to costs of protection (sheet pile and caissons) and the building materials needed for an ocean environment. Also, the building costs were inflated due to high costs providing utility services to the building. The estimates of depreciate replacement value for structure was based on Marshall & Swift and the Corps Cost Engineering Section.

The Capistrano Shores trailer park, opened in 1963, consists of 90 mobile homes and a clubhouse along an approximate 1,100-meter coastal segment orienting in a northwest to southeast direction (**see Figure 2-10**). A timber seawall armored with riprap was later constructed along the entire stretch of the trailer park in the late 1960's to prevent storm damage and shoreline retreat within the project site. The existing seawall has two return sections, approximately 10.5 meters long on the northwest end and about 12 meters long on the southeast end respectively.

Table 2-17. Depreciation Replacement Values of Facilities on Public Beach

Facility	Square Footage m^2 (sf)	Current Protective Measures	Depreciation Replacement Value
Marine Headquarters	527 (5,675)	Sand Beach/Sheet Pile Wall	$885,000
North Beach Concession and Restroom	89 (960)	Sandy Beach/caissons	$135,000
Linda Lane restroom	61 (660)	Sandy Beach/sheet Pile wall	$54,000
Picnic Shelters north of Pier	46 (500)	Sandy Beach	$21,000
Concession south of Pier	74 (800)	Sandy Beach	$47,000
Restroom South of Pier	61 (660)	Sandy Beach	$64,000
Picnic Shelters south Pier	46 (500)	Sandy Beach	$21,000
Restroom at T-Street Beach	92 (1,000)	Sandy Beach/sheet Pile wall	$117,000
Concession stand at T-Street Beach	44 (480)	Sandy Beach/sheet Pile wall	$33,000
Restroom south of T-Street Beach	92 (1,000)	Sandy Beach/sheet Pile wall	$78,000
Miscellaneous playgrounds and fire Rings	NA	Sandy Beach	$20,000
Total Costs			$1,475,000

2.9.4 Transportation

In 2000, there were 2,117,514 vehicles registered in Orange County alone. In 2003, the county had over 1,668 miles of streets, roads, and highways. Major interstate highways servicing the county and study area include Interstate 5 and Pacific Coast Highway both running north and south.There are other freeways connecting cities notably I-405 (north and south); 91, and 73 running east and west.

San Clemente is located halfway between Los Angeles and San Diego, approximately sixty miles from both. Roughly parallel to the coastline, the North/South arterial freeway, Interstate Five, is less than ¾ of a mile inland from the beach and serves San Clemente with five freeway exits. Highway One, the Pacific Coast Highway, runs north from San Clemente, providing local access and scenic travel along the coast. Six major airports are within 75 miles of San Clemente. The closest, John Wayne Airport in Santa Anna, is 28 miles away, and is served by American, Delta, Southwest, United, and other domestic carriers.

San Clemente's railway stop is at the foot of Avineda Del Mar, directly opposite the Municipal Pier. Amtrack's Pacific Surfliner train stops in San Clemente several times a day as it travels between San Luis Obispo and San Diego. Orange County has a Metrolink train system that provides commuters with access to Los Angeles, Riverside, San Bernardino, Ventura, and North San Diego counties. The seven-year old commuter train operates a total of 126 daily trains running over 416 miles of track. The study area is also serviced by Amtrak as part of the Los Angeles to San Diego Corridor.

While the majority of visitors to San Clemente's beaches travel by car, more than a third of overnight guests fly to the area, and a significant number of local visitors walk to the beach or come by train. **Table 2-18** lists the principle modes of travel by frequency for all visitors who participated in the survey, based on beach surveys taken in 2002.

Table 2-18. The Method of Travel to San Clemente's Beaches

Mode of Transport	Frequency (%)
Car	71%
Airplane	13%
Walk	8%
Train	5%
Other/NA	3%

2.9.5 Railroad Corridor

The Lossan corridor (Los Angeles to San Diego) is the only railroad link between San Diego and the rest of the United States for passenger and freight railroads to operate, including military operations. This corridor is a major transportation link for passenger traffic, second only to the Washington DC to Boston corridor in terms of Amtrak train density and ridership.

2.9.5.1 History of The Railroad

In 1882 the Atchison, Topeka, and Santa Fe Railway Company (ATSF) constructed the rail line connecting San Diego to San Bernardino, but this line was abandoned after two severe flood episodes that damaged the route. The ASTF constructed the Lossan corrider in 1888. The railroad line connected the cities of Fullerton and San Diego.

During the 1980's ATSF, Caltrans, Amtrak and Los Angeles, Orange and San Diego counties shared the cost ($79 million) of the Lossan Rail Corridor Rehabilitation project. The project included replacement of the 50-year old jointed rail with new, heavier continuous-weld-rail; new wood railroad ties; installation or replacement of some power switches; and surfacing. In addition, since the 1980's the railroad and government agencies have spent $852 million in improving the infrastructure along the Lossan corridor.

The ATSF maintained and operated the Lossan corridor until 1993 when it was sold to the Orange County Transportation Authority (OCTA). The purchase by OCTA was funded by bond proceeds, the passage of propositions 108 and 116 in 1990, and by the proceeds from local transportation sales tax measures. Conditions of the purchase from the ATSF included the obligation to continue operation of ATSF and Amtrak trains, and the protection of utilities within the right of way. OCTA has assigned the maintenance of the line and operation of commuter trains to the Southern California Regional Rail Authority (SCRRA). This maintenance activity includes track and tie inspection and the periodic repairs. Also, there is on-going vegetation control and debris removal along the right-of-way, as well as periodic replacement of rip rap to protect the track bed from wave action.

2.9.5.2 Existing Operations

In 1996 the ATSF merged into a new corporation, the Burlington Northern and Santa Fe Railway (BNSF). Currently, this line connects with other railroad lines in San Diego.

Also, this line connects to the Tijuana and Tecate areas of Baja California Norte (Mexico).

When Amtrak took over passenger service from the Atchison, Topeka & Santa Fe (BNSF) in 1971, only three daily "San Diegan" passenger train round trips were being operated. Eighteen San Diegan trains currently operate daily along this route, nine in each direction.

In 1992 Metrolink commuter rail service began on six local corridors centering in Los Angeles and Orange Counties. Metrolink operates 19 trains per day on the Orange County route. An average of 377 passengers board at the Oceanside and San Clemente stations daily (June 2000).

The Amtrak's Pacific Surfliner provides service to the San Clemente station. The Surfliner provides service from San Diego to San Luis Obispo. The service carried more than 1.7 million passengers in FY 2002. The Pacific Surfliner Corridor serves Southern California's key coastal population centers and connects two of the most congested regions in the country – Los Angeles and San Diego.

The Burlington Northern Santa Fe Railway operates on average, 4 daily trains. Trains operating during the day average 4,800 tons, which is approximately 60-65 trains cars in length. Trains operating at night are typically auto trains (the trains are approximately 6,500 feet in length). During periods of peak freight activity, BNSF may run 6 trains a day on this segment of the Lossan corridor. In addition to general freight, the line handles fuel gas, bulk chemical shipments to the Port of San Diego (principally potash), feed grain, automobile, lumber, and transportation, construction, and military equipment. Also, this line serves the Camp Pendleton Marine Corps Base, the Miramar Naval Air Station, the Southern California's San Onofre nuclear plant, and the San Diego Unified Port District.

2.9.5.3 Future of the Railroad

For the year 2020 SCRRA forecasts 58 trains carrying 17,760 per weekday and Amtrak forecasts 32 trains carrying 5,760,000 annual passengers (averages 15,781 per day but actually peaks on Friday, Saturday, and Sunday).

Freight service is also expected to grow in the future. Projections by San Diego Association of Government show variable projections indicating freight cargo movements along the LOSSAN corridor increasing 20 to 50 percent by the year 2022. The estimates could increase larger depending on industry growth along the United States-Mexico border related to the effectiveness of NAFTA and the success of the maquiladoras and associated industries.

2.9.5.4 High Speed Rail Plan

The rail line has discussed the future possibility of a high-speed rail corridor that would relocate the existing line through San Clemente to somewhere along Interstate 5. At this time though, this possibility is in a conceptual stage. There are no defined plans, schedules or funding currently in place to support this concept. In addition, there are significant financial, political, public, and technical challenges that will require resolution prior to implementation of such a large-scale project. Therefore, relocation of the rail line is not being considered in this analysis. There is no way to determine if or when the project would be viable in the future.

2.9.6 Beaches in San Clemente

San Clemente's beaches are sandy and relatively narrow. Except for a pedestrian overpass at the end of Avenue Esplanade and a tunnel under the tracks at the north end of Plaza la Playa, visitors must cross the railroad tracks to visit the beach. There are three jurisdictions responsible for maintaining the recreation use of the study area beaches including: San Clemente State Beach, San Clemente's City Beach including North Beach and private beach adjacent to the Shorecliff Mobil Home Park. The State Beach extends for 1½ miles north from San Mateo Point to Avenide Calafia. The City Beach is a little more than 2 ½ miles long, from Avenida Calafia up to Avenida Pico, at the Ole Hanson Beach Club. The private beach is approximately ¾ miles in length from Avenida Pico to Camino Capistrano.

Amenities at the State Beach are relatively sparse, but include restrooms, outdoor showers, camping, picnic areas, a snack bar, and parking. The southern part of San Clemente's City beach (at T street and south) is similar to the north beach in terms of amenity levels. It attracts locals, including surfers. North beach, mainly frequented by locals, provides significantly fewer amenities than the main City beach area, though it does offer lifeguard services, rest rooms and a few other minor facilities.

Walk-in access to both the City Beach and the State Beach is free. To park, visitors pay a fee of $5.00/vehicle for day use at the State Beach, and an estimated 30% of drivers visiting the City Beach use metered parking at the rate of $1.00/hour. Campers at the State Beach staying in one of the 160 campsites pay $12/day, which includes parking and access to the beach.

2.9.7 San Clemente Municipal Pier

The town and the Municipal Pier itself were both developed by Ole Hanson during the land boom days of the "Roaring' Twenties." His vision foresaw a "Spanish village by the sea," where all the houses were white with red tile roofs. The pier is located over a sand beach and the pier's pilings, which were built in 1928, are heavily covered with mussels. In addition, a reef was constructed out near the end of the pier. The pier is heavily used for sport fishing and offers restaurants, a tackle store and other recreational shops.

2.9.8 Recreational Activity

San Clemente is one of the most popular recreational areas for surfing. The City is the headquarters of the Surfrider Foundation, claiming 29 chapters nationwide and a membership of 25,000. There are eleven thriving surf shops and over a dozen major surf industry manufactures, five of the world's most prestigious surf publications, as well as five surf schools and camps in the City. The San Onofre Surf Club is the oldest and largest in the world. San Clemente surfers have won championships in every competitive circuit and nearly every category in the United States. The popularity of surfing is related to some of the most outstanding wave conditions on a consistent basis, which include the areas from the "204" and the Pier, to T-Street, Riveria and State Park. In addition, the back area is heavily used for sun bathing, picnicking, swimming and beach-related sports.

The City of San Clemente beaches and pier provide a major focal point for the community and community activities. In addition to its usual popularity for recreation use, it provides the venue for two of the City's highly popular annual weekend events including the Ocean Festival and the Sea Fest. These yearly events attract tens of thousands of visitors to the area providing numerous family activities, cook-offs, and arts and craft shows.

2.9.9 Attendance

Annual attendance at San Clemente's beaches in terms of beach days (i.e., each time an individual goes to the beach during the day it is counted as a beach day) has steadily grown at an average rate of 2% per year. From 1992 through 2001, people visited San Clemente's City and State beaches an average of 2.15 million times each year, with the City beach accounting for 89% of all visits. **Figure 2-26** shows a photo of beach use during a high use day. Sixty percent of visits to San Clemente's beaches take place during the "high" season, which we define as between Memorial Day and late September.

Based on information from interviews with City officials and beach surveys, it is estimated that 70% of the current City beach visitors go to Reach 6. Of the remaining 30% of City beach attendance, 18% go to reach 8 and 12% go to reaches 1-4. Among the annual visitors, just over 17% of total visitors in Reach 6 and approximately 20% of visitors in Reaches 1-4 and 8 are at the beach for the surfing activity. Since surfing is a year round activity, in contrast to swimming, surfers represent a higher proportion of off-season visitors and a lower percentage of high season visitors. The detailed attendance data can be found in the Economic Appendix.

2.9.10 Future Beach Use

Over the past ten years, attendance at San Clemente's beaches has grown by roughly 2% a year, which corresponds closely to the rate of population growth in Orange County. It is assumed that the attendance at San Clemente's beaches will continue to grow with population. **Table 2-19** summarizes the estimated population growth for Orange County and the corresponding increase in attendance.

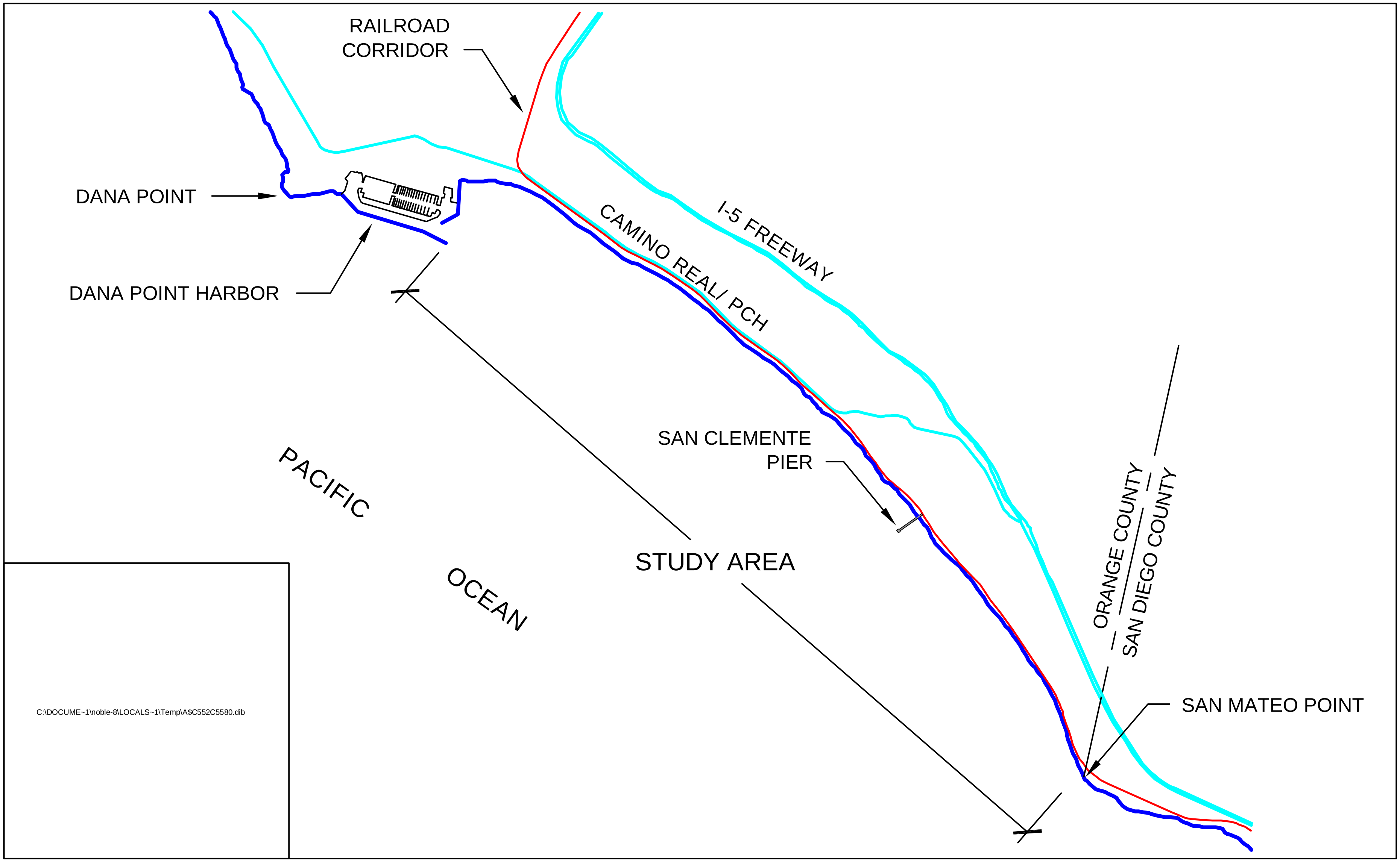
Table 2-19. Population Growth in Orange County and at San Clemente Beaches

Year	Orange County Population (thousands)	Percentage Population Increase (%)	Percentage Beach Attendance Growth (%)
1990	2,398	20.6	1.9
2000	2,893	7.2	1.38
2005	3,100	5.4	1.05
2010	3,267	3.6	0.70
2015	3,384	4.7	0.91
2020	3,542	4.0	0.78
2030	3,684	4.0	0.78
2040	3,831	4.0	0.78
2050	3,984	4.0	0.78
2055	4,144	4.0	0.78

The growth of the beach attendance does not directly correlate to the proportional increase in each reach. It is believed that the attendance in Reach 6, particularly the area around the pier will not grow over time, since the capacity is already strained. In particular, parking is limited and the beach is already crowded on weekdays and weekends in the summer. A summary of estimates for beach attendance by reach is given in **Table 2-20**. The detailed description is provided in the Economic Appendix.

Table 2-20. Estimated Annual Attendance By Reach

Year	Estimated Attendance in Reach 6 (thousands)	Estimated Attendance in Reaches 1-4 (thousands)	Estimated Attendance in Reaches 8 (thousands)	Estimated Attendance in Remaining Reaches (thousands
2000	1,467	642	141	783
2005	1,467	774	170	944
2010	1,467	880	193	1,074
2015	1,467	995	210	1,165
2020	1,467	1,056	232	1,88
2030	1,467	1,146	252	1,398
2040	1,467	1,240	272	1,12
2050	1,467	1,338	294	1,632
2055	1,467	1,439	318	1,755



Study Area Map

Figure 2-1

Reach 1 - San Mateo Point to Palmeras

Figure 2–2

Reach 2 - Palmeras to 3800 Block, Vista Blanca

Figure 2–3

Reach 3 - 3800 Block, Vista Blanca to Calafia

Figure 2–4

Reach 4 - Calafia to Primavera

Figure 2–5

Reach 5 - Primavera to Cristobal

Figure 2–6

Reach 6 - Cristobal to Linda Lane

Figure 2–7

Reach 7 - Linda Lane to 1200 Block, Buena Vista

Figure 2–8

Reach 8 - 1200 Block, Buena Vista to Pico

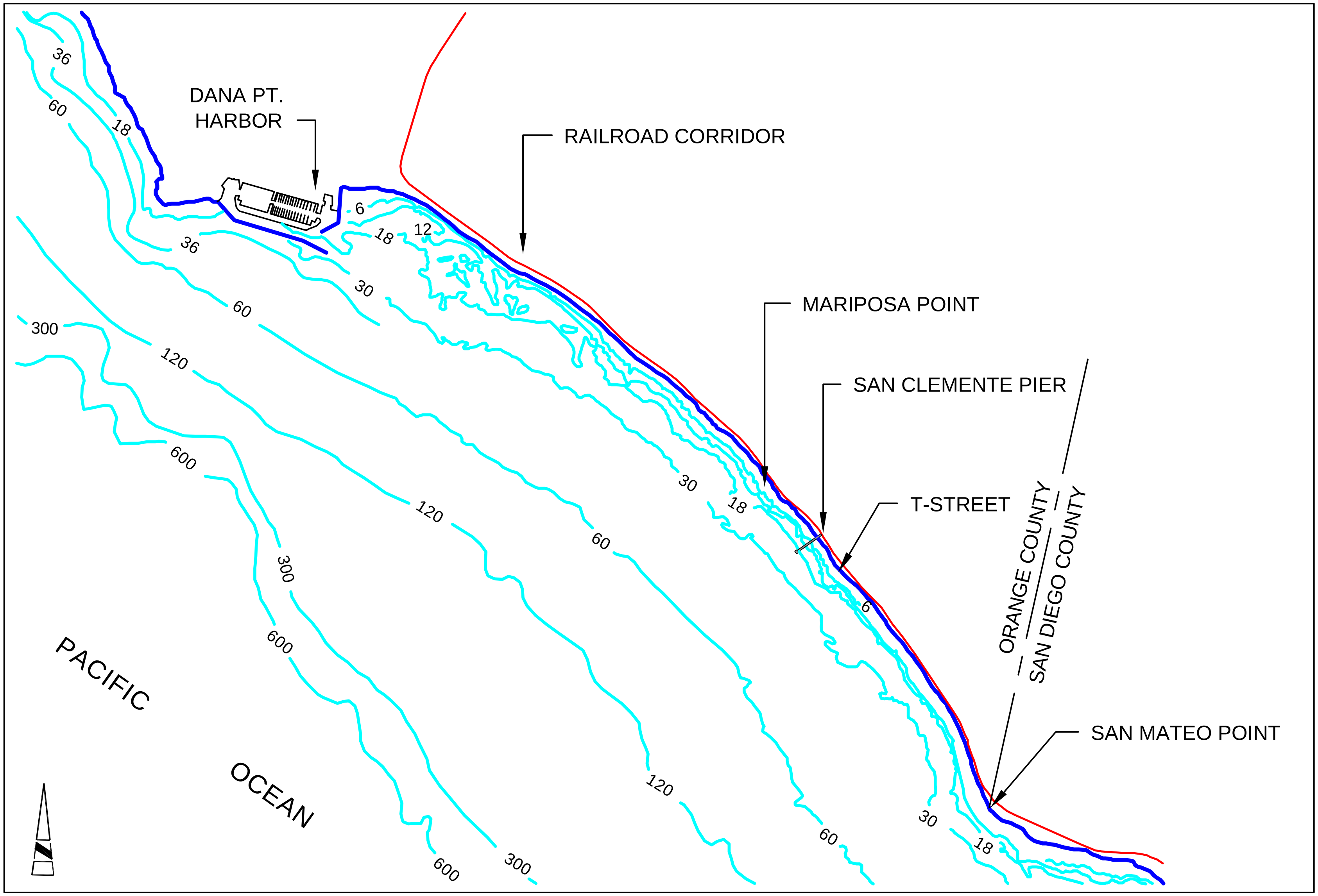
Figure 2–9

Reach 9 - Pico to San Andreas

Figure 2–10

Reach 10 - San Andreas to Dana Point Harbor

Figure 2–11

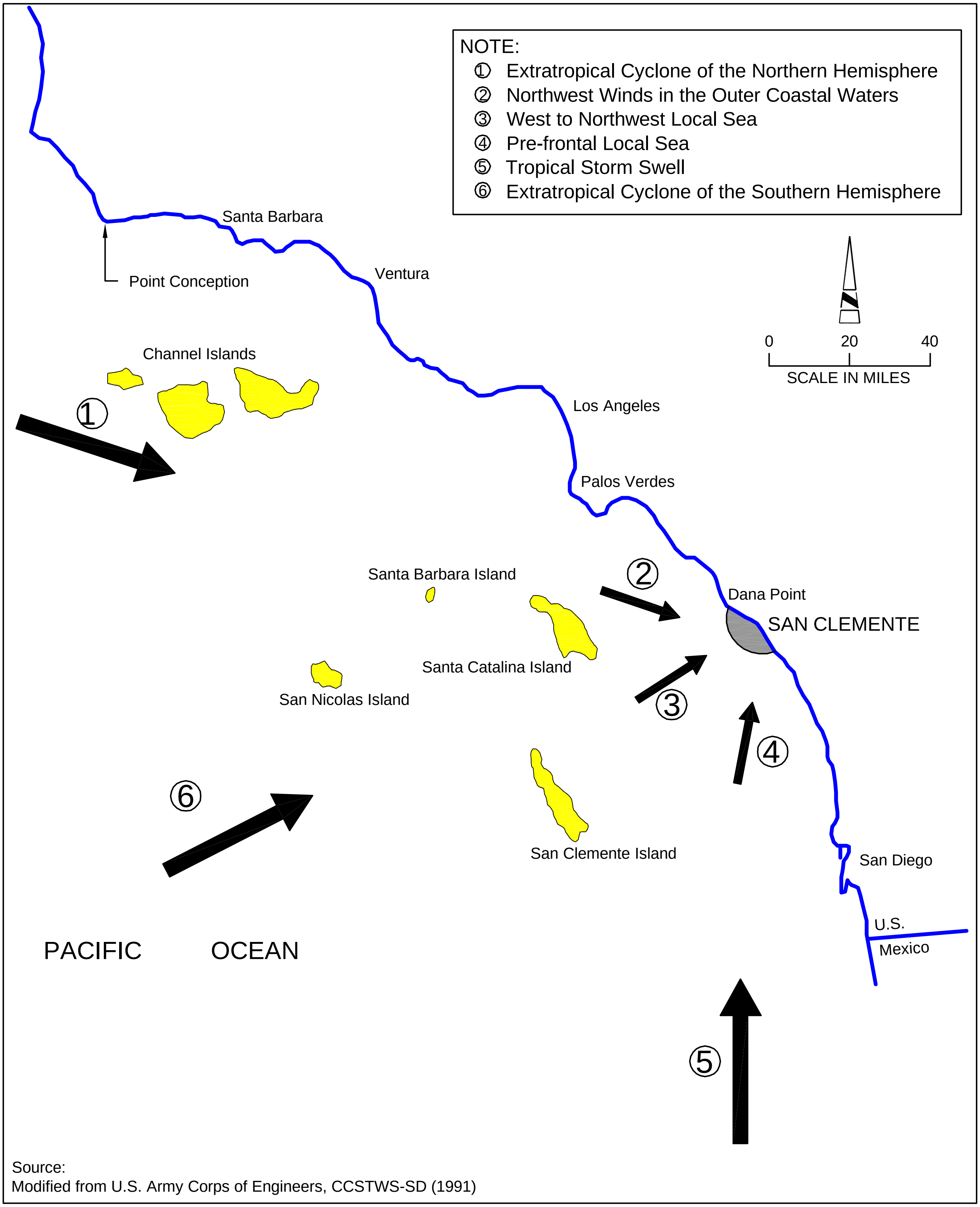


Note: Depths in ft., MLLW

Bathymetry

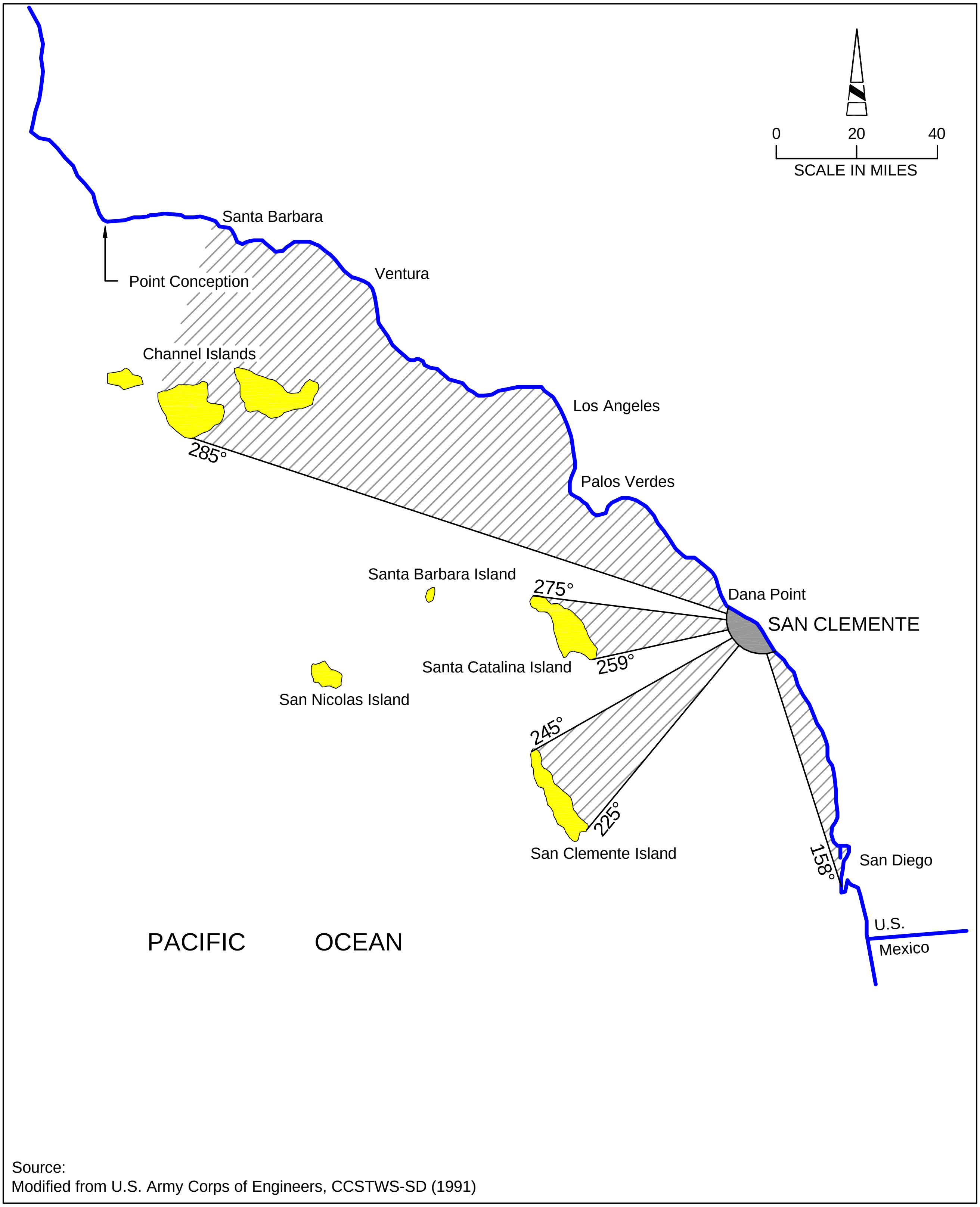
Source: USGS Dana Point Quadrangle, revised 1975

Figure 2-12



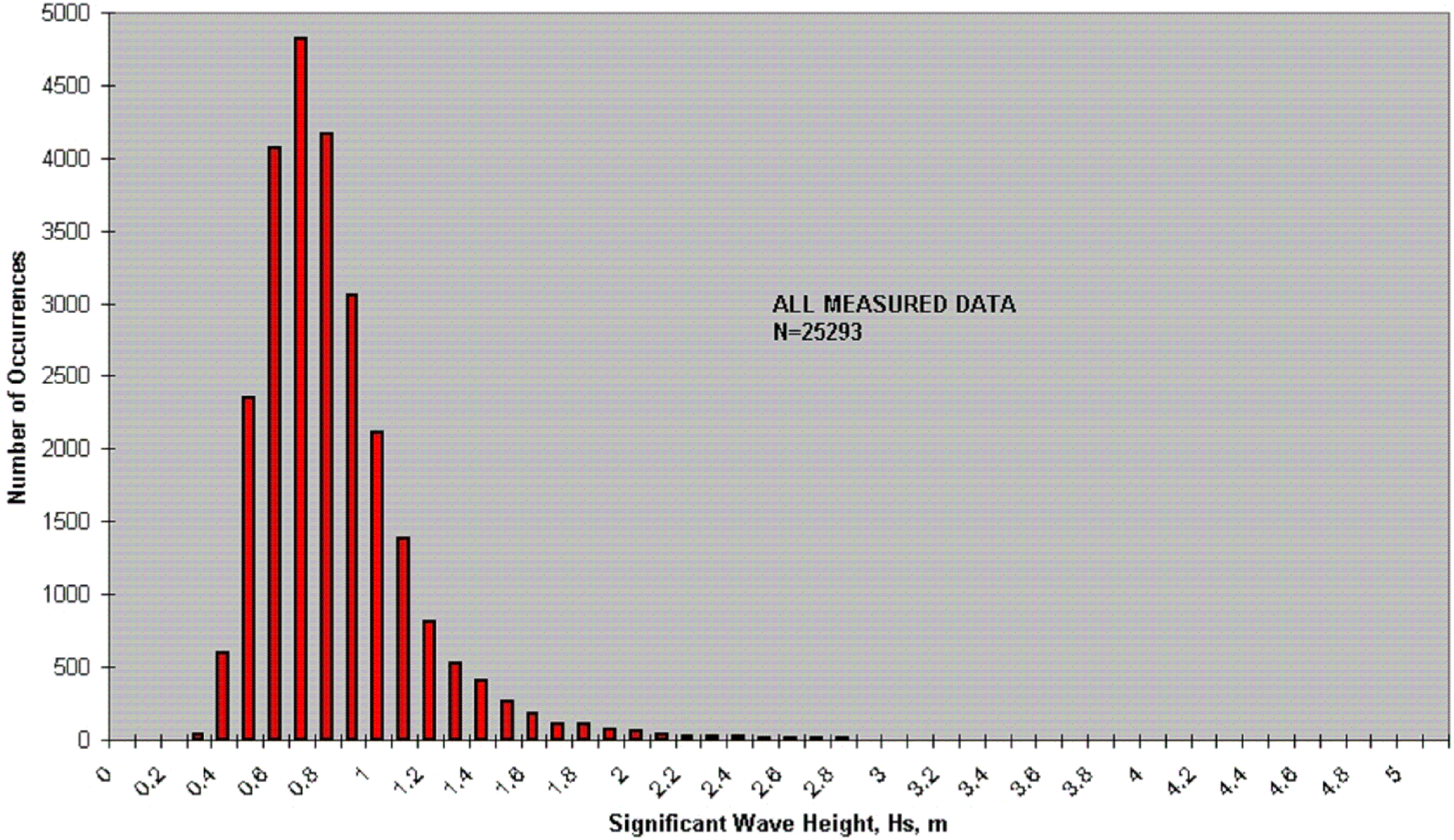
Meteorological Wave Origins Impacting Project Area

Figure 2-13



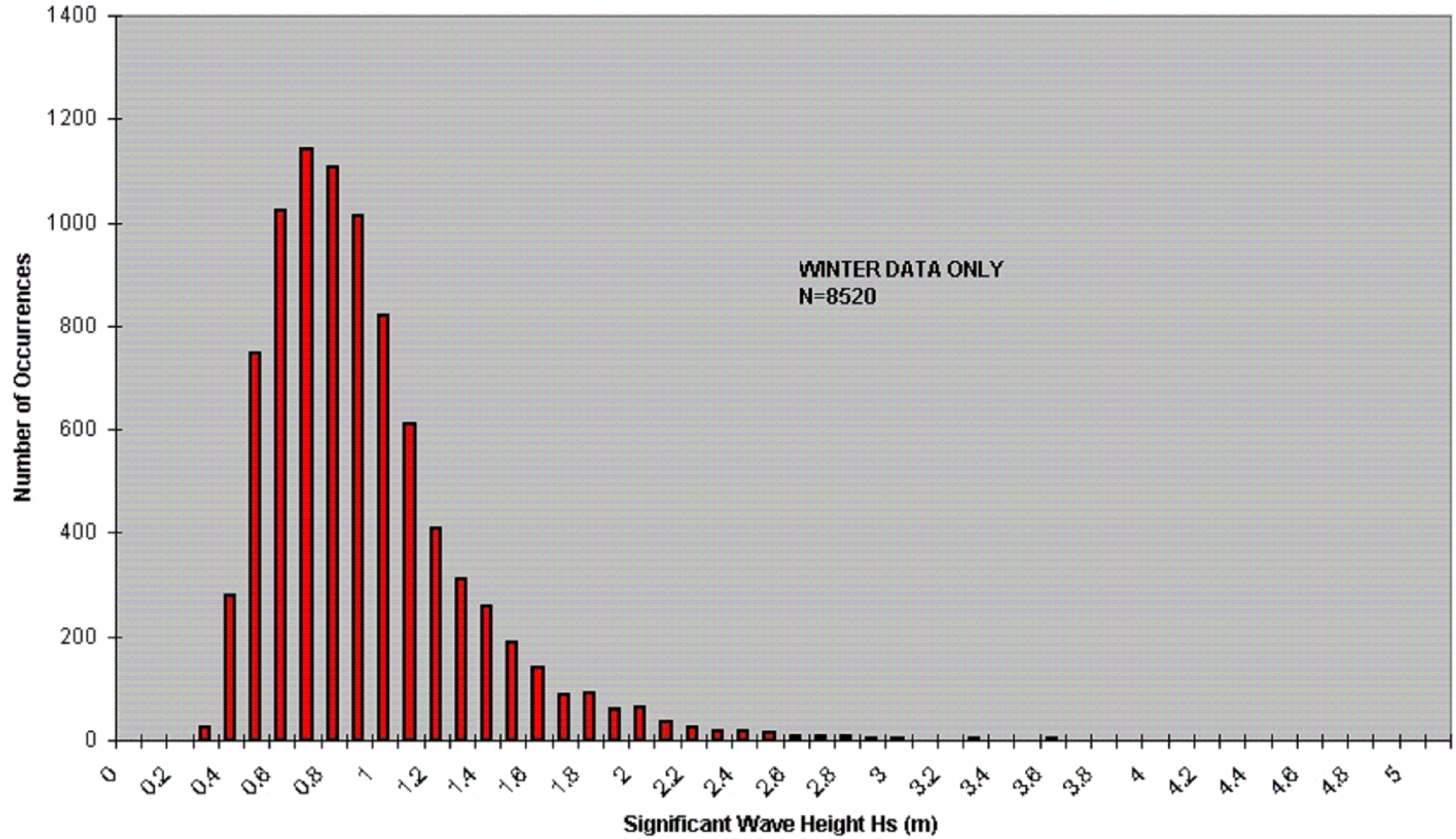
Wave Exposure Windows

Figure 2-14



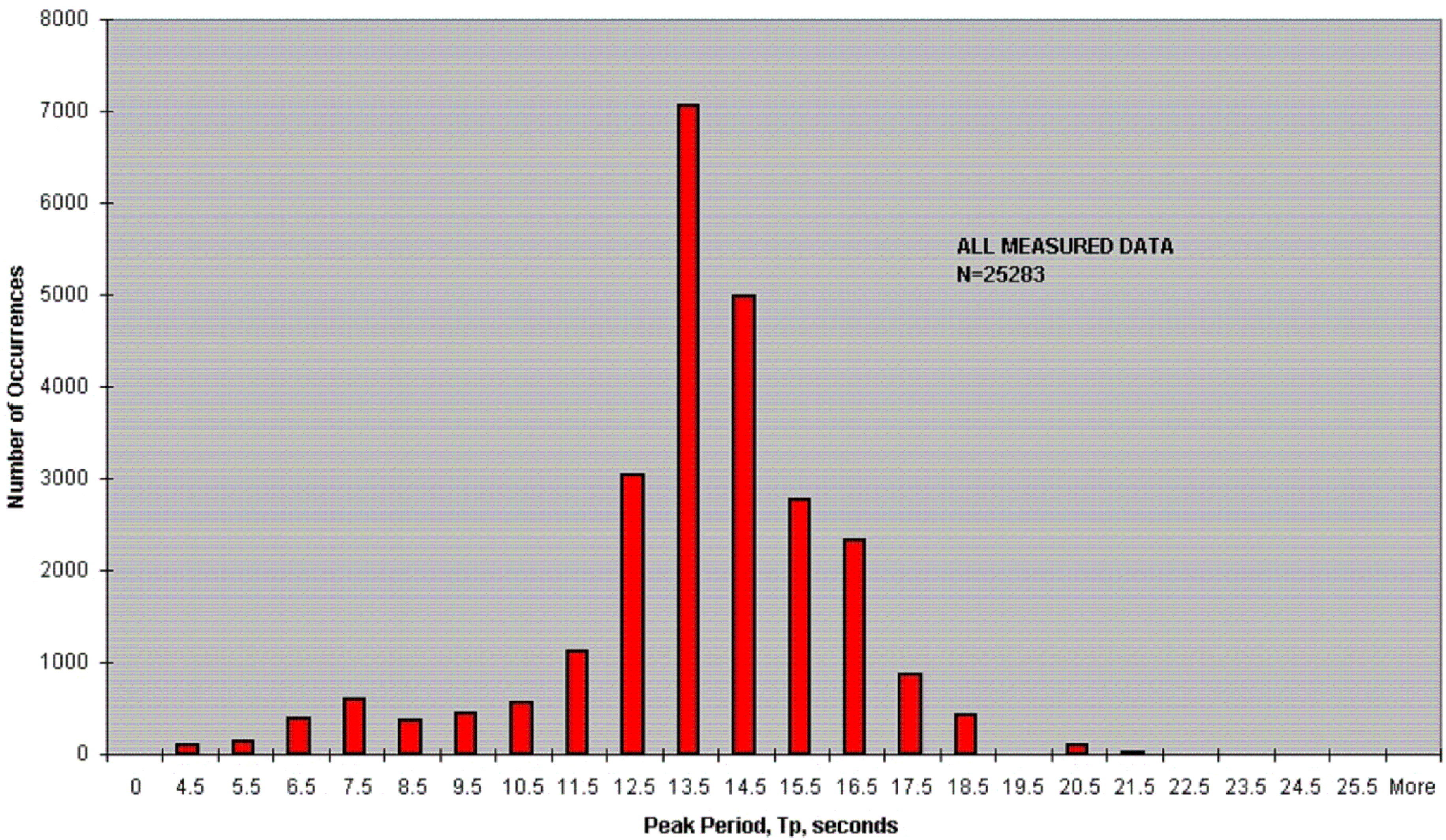
Significant Wave Height Histogram, 1983 - 1998

Figure 2-15



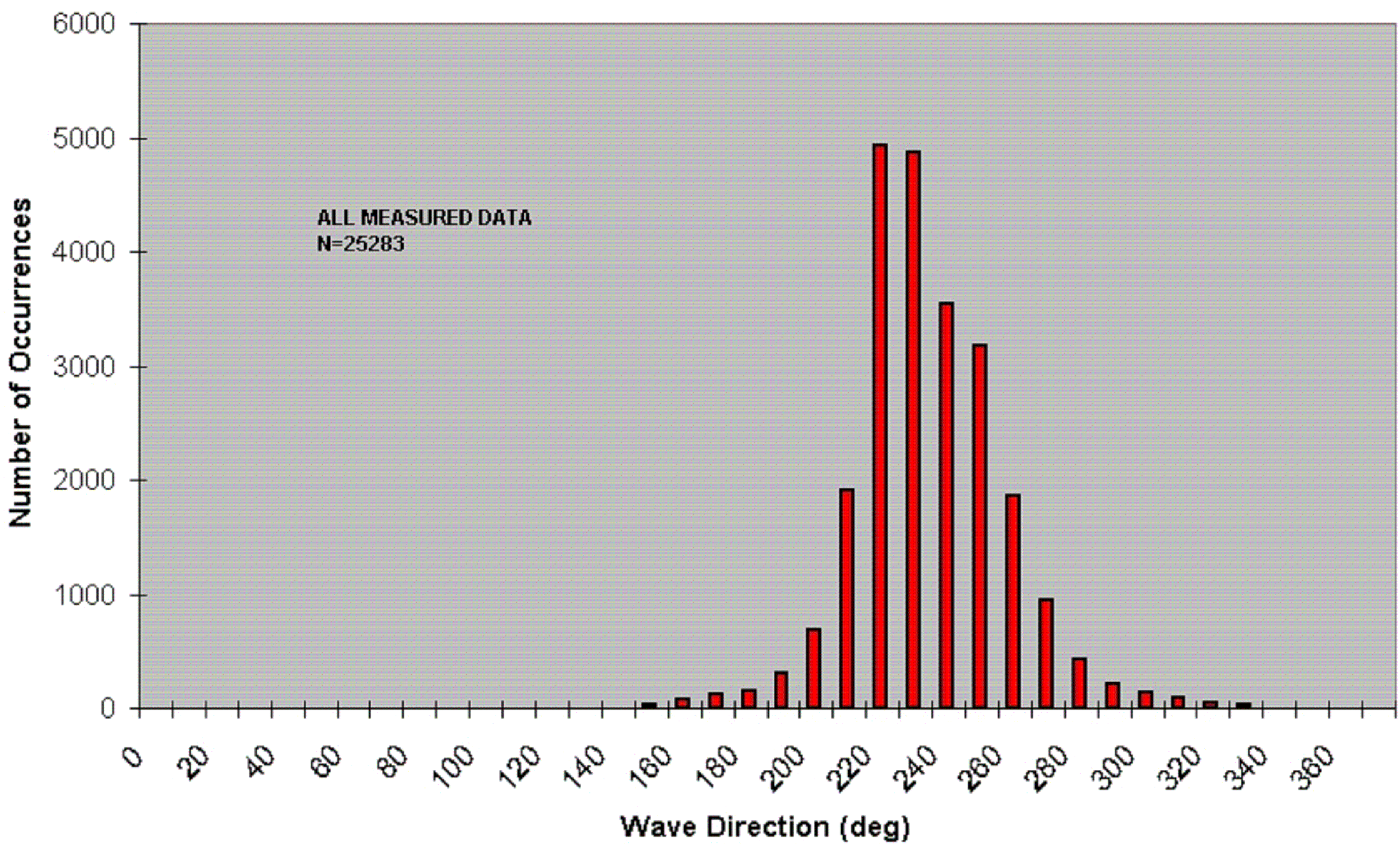
Significant Wave Height Histogram, Winter Data,1983 - 1998

Figure 2-16



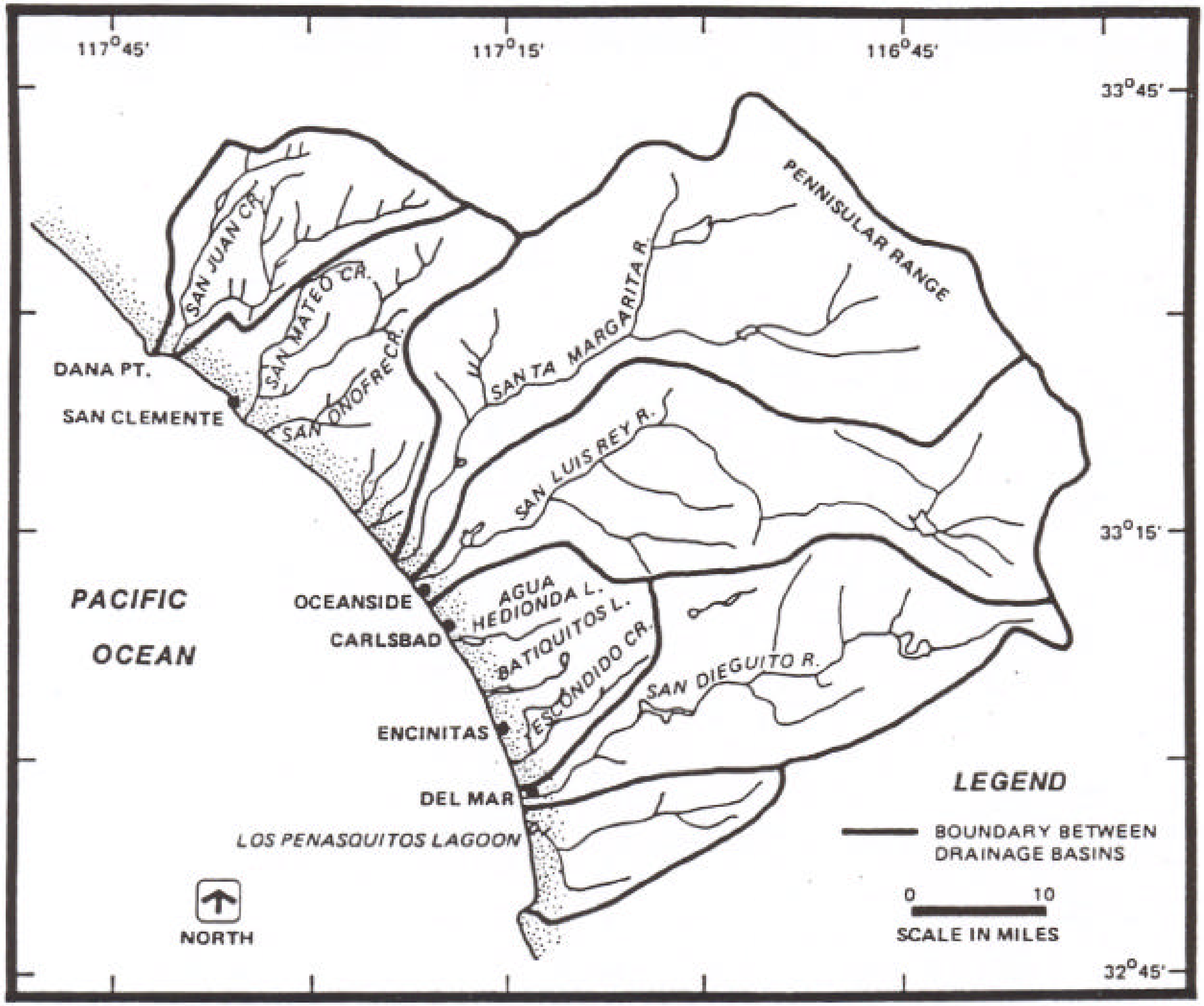
Spectral Peak Period Histogram, 1983 - 1998

Figure 2-17



Wave Direction Histogram, 1983 - 1998

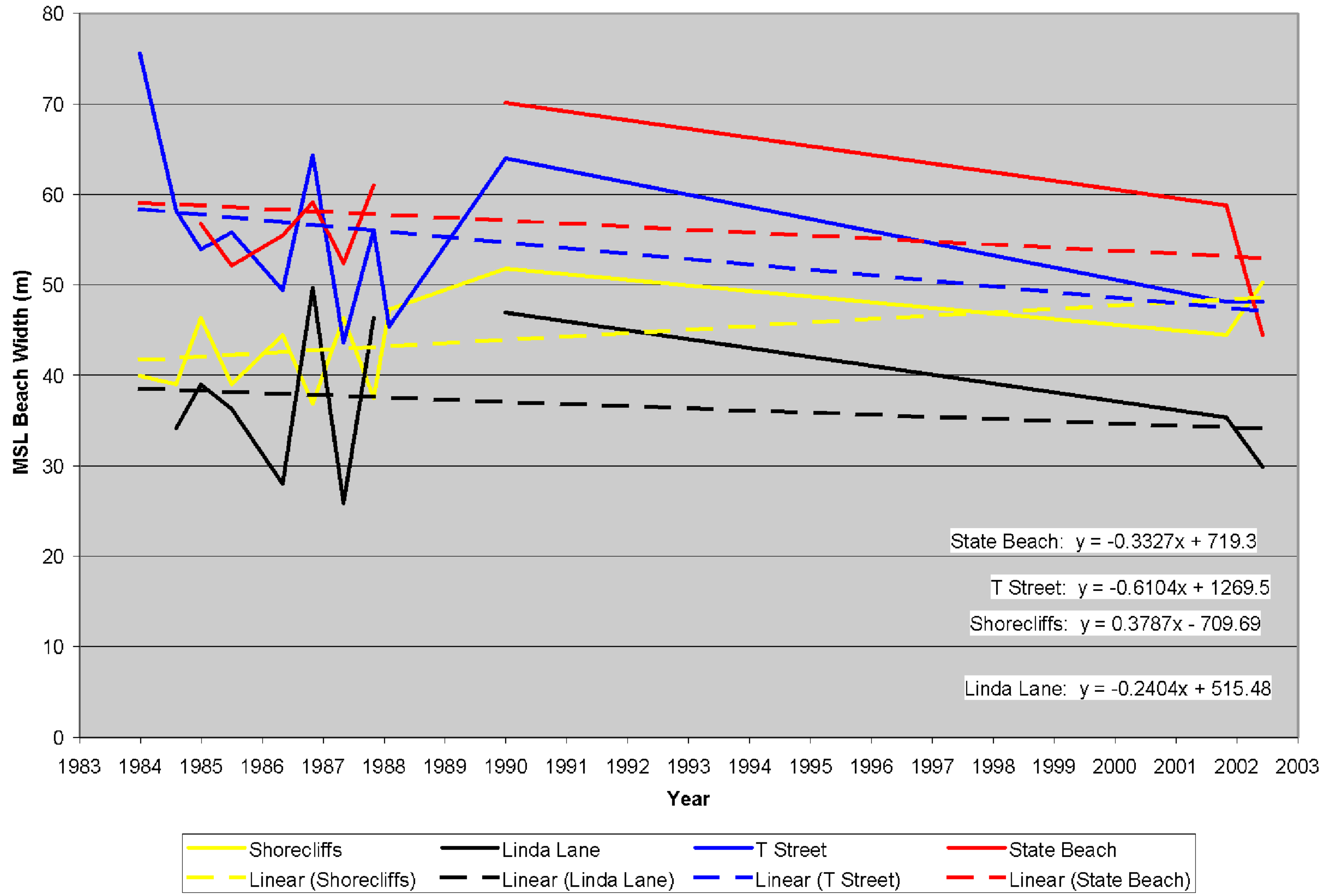
Figure 2-18



Fluvial Sources within Oceanside Littoral Cell

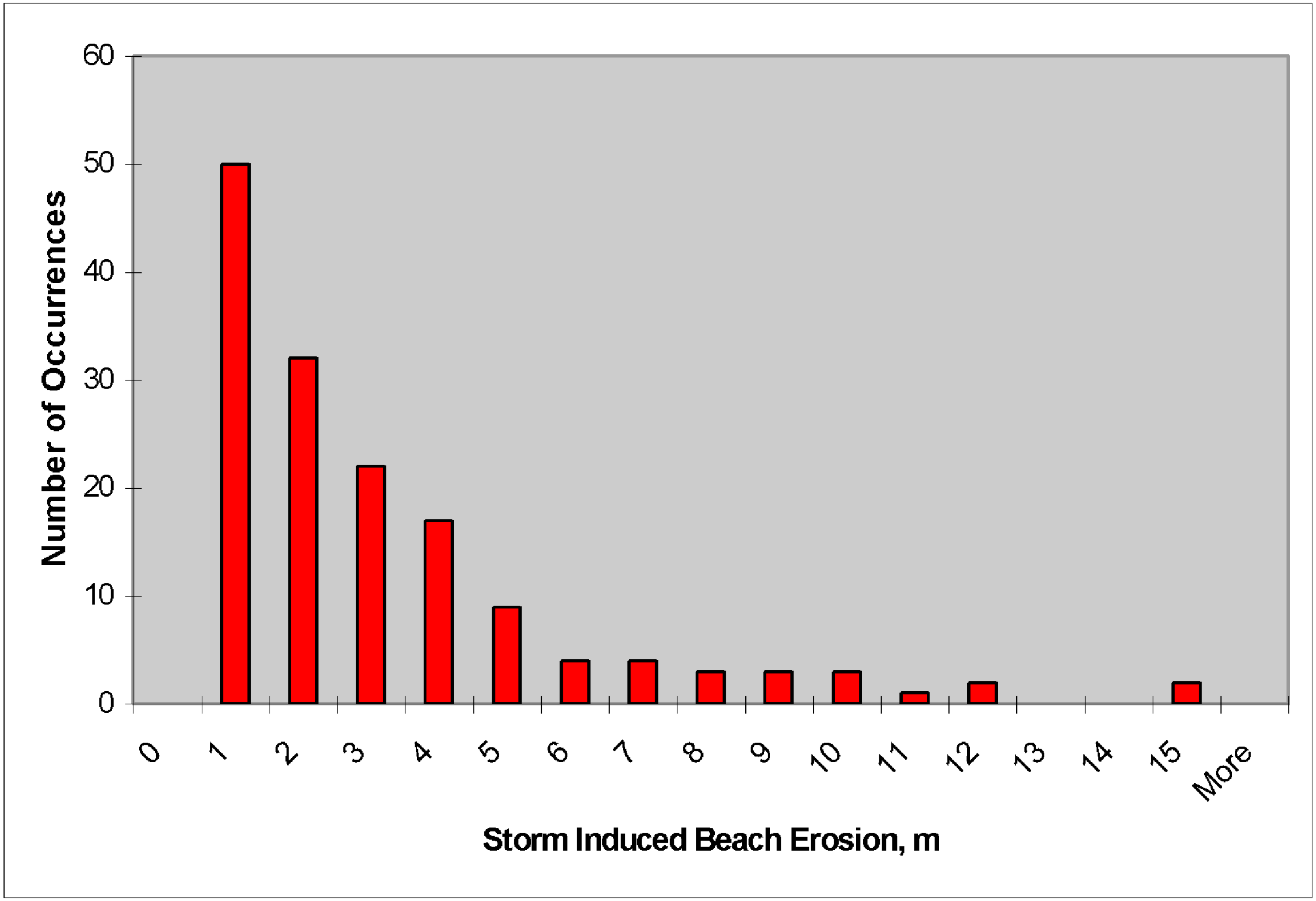
Source: U.S. Army Corps of Engineers, CCSTWS-SD (1991)

Figure 2-19



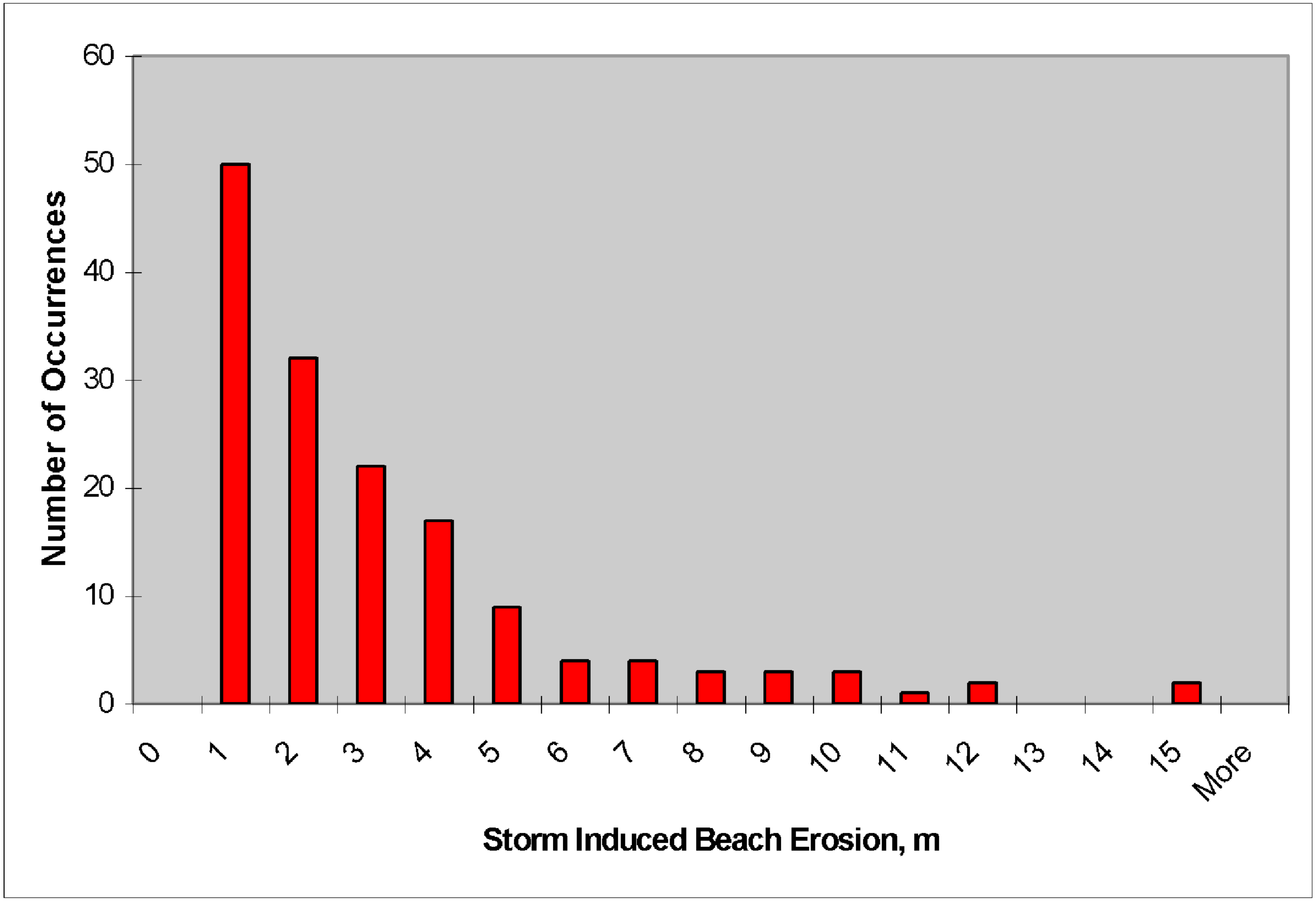
Recent Shoreline Change in San Clemente Area

Figure 2-20



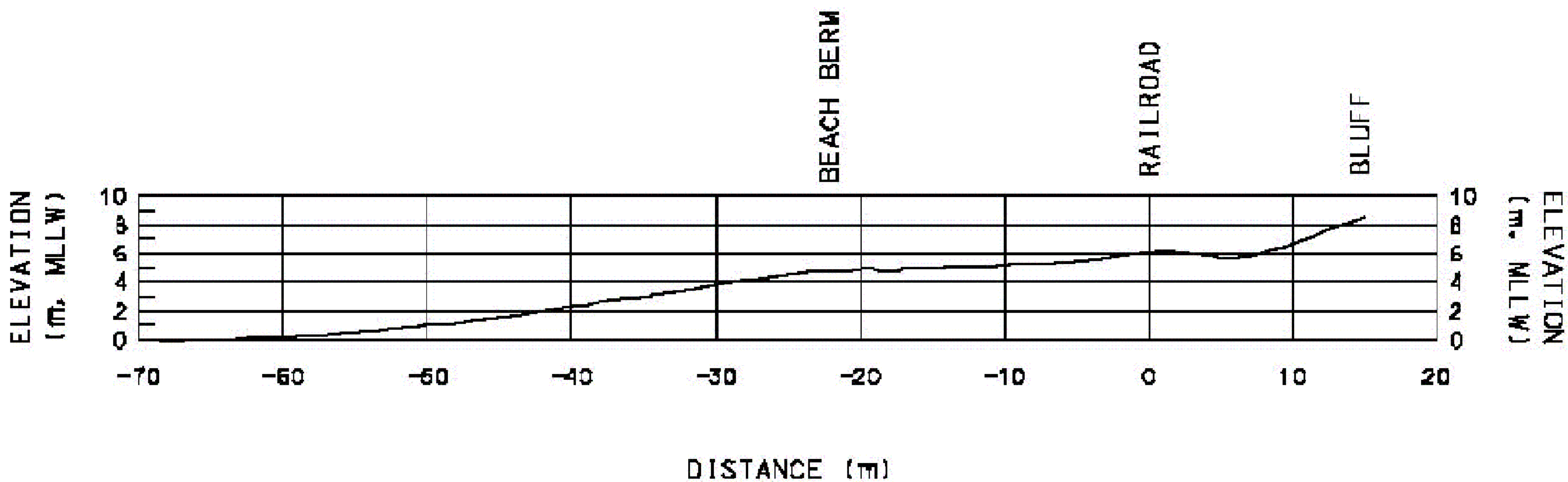
Storm Induced Beach Change Histogram

Figure 2-21



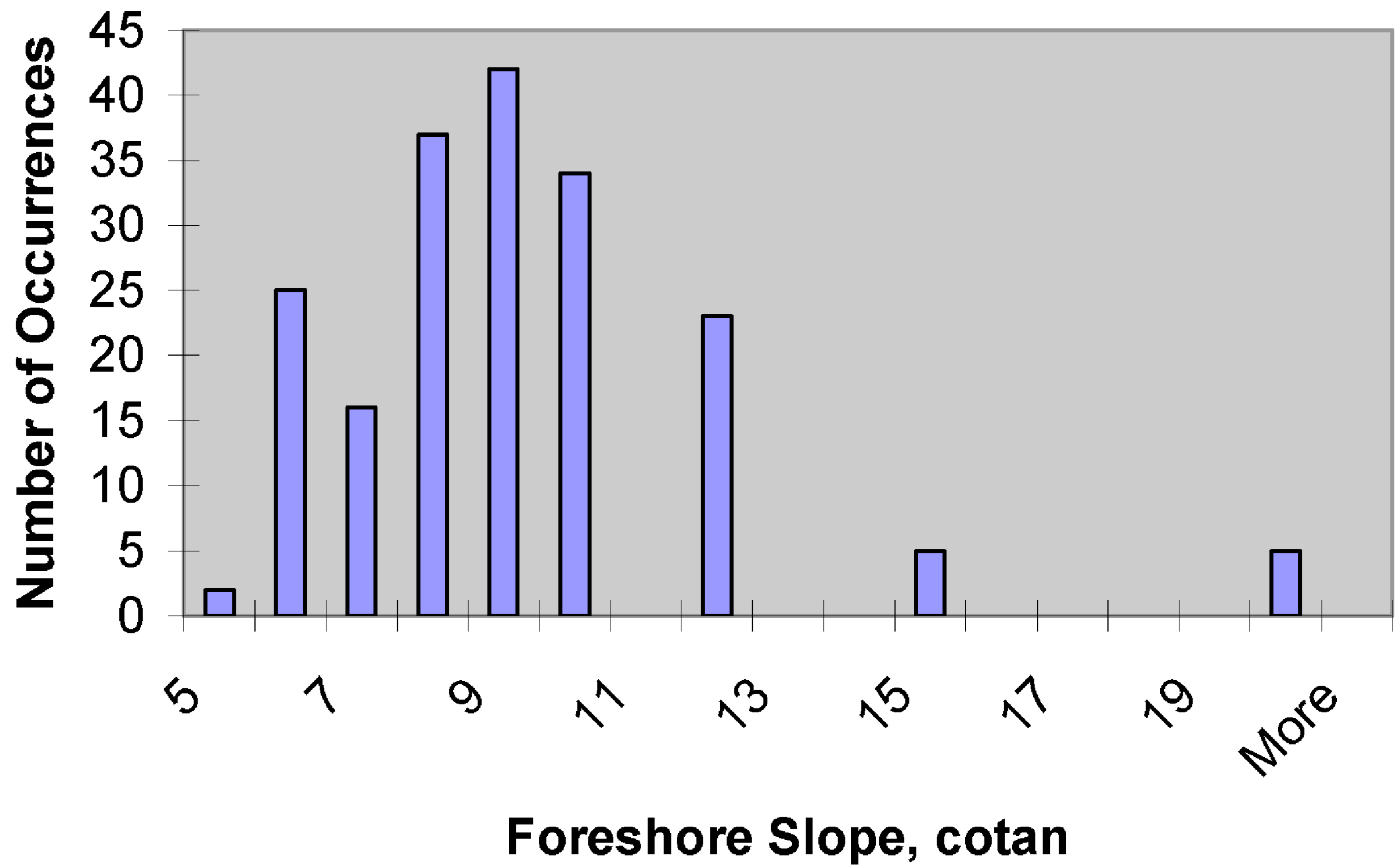
Storm Induced Beach Change Histogram

Figure 2-22



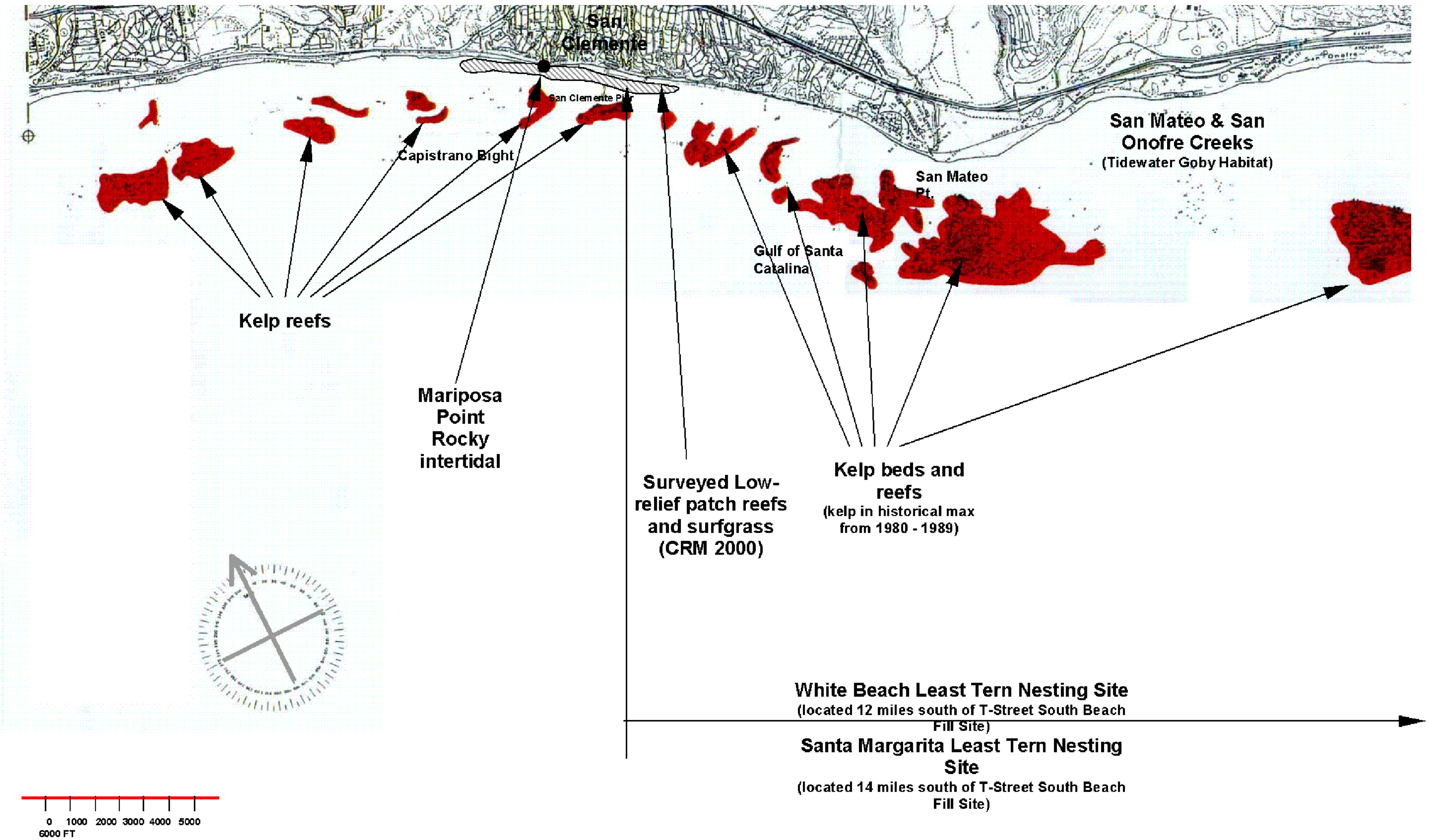
Typical Cross-Section - Reach 2, 4, 6 and 8 (No Revetment)

Figure 2-23



Foreshore Slope Histogram

Figure 2-24



San Clemente Beach Biological Resources

Figure 2-25

Source: Shore & Beach, 2004

San Clemente Beach During a High Use Day

Figure 2-26

3.0 STATEMENT OF PROBLEMS

3.1 Historical Perspective

Prior to the 1990's, the beaches within the study area were quasi-stable as sufficient sand was injected from the San Juan Creek to the Oceanside littoral cell. This was prior to upland urban development that deprived the sand supply. However, the protective buffer beaches were relatively narrow as is evident from the historical aerial photographs taken in 1938, 1954, 1960,1970, 1980, 1983, 1988 and 1994. **Figures 3-1** through **3-8** show the above-identified aerial photographs. These aerial photographs illustrate the relative narrowness of the beach width. The documented historical beach width above the Mean Sea Level (MSL) line between T Street and Mariposa Point was as narrow as 25 meters in the winter months (USACE-LAD, 1991). As a consequence, storm damages did occur in the past (e.g. 1964, 1983, 1988 and 1993), as the protective buffer beach width was narrow, particularly in the winter season.

Since the 1990's, the study beaches have experienced gradual erosion probably due to the decrease of fluvial sand supply resulting from channel concretization of creeks and rivers, damming, and urban development. Over the past 10 years, average beach widths in the City's beaches have been gradually reduced as described in Section 2-5. The greatest reduction in beach width during the last decade has occurred within the 1,370-meter (4,500-foot) stretch from Mariposa Street to Cristobal Street (also known as T Steet). As a result of shoreline retreat, storm waves impinge directly upon the protective revetment, which significantly threatens the operation of the rail corridor and may damage the railroad ballast. The reduction has also subjected City facilities and private properties to storm wave-induced damages. These facilities, maintained by the City of San Clemente, include the Marine Safety Building, public restroom facilities located on the beach, lifeguard stations, parking areas, and paving near the pier.

3.2 Railroad Service Interruption and Delay

The LOSSAN railroad line is constructed on conventional elevated crushed rock ballast along the base of the entire study area's coastal bluff. The railroad line is a prominent feature that completely separates the active coastline from the coastal bluff and adjacent backshore development. The LOSSAN railroad line is a vital transportation link for passenger and freight service. In addition, the Department of Defense has designated this right-of-way as a Strategic Rail Corridor with great significance to National defense. Railway traffic service delays occur when storm wave runups exceed the elevation of SCRRA protective revetments or the crest of the railroad ballast in the without-revetment segments.

As documented by the SCRRA, railway traffic service delays have occurred when waves overtopped the structures during severe storms in the past. Two service disruption incidents of approximately 24 hours occurred in the 1960's and 1970's (McGinley, 2003) at Mariposa Point (north of the pier) and at a location south of the pier, respectively. The failure was due to wave backwash upon overtopping the railroad ballast that eroded the embankment.

Due to chronic beach erosion in recent years that resulted in storm wave attack directly against the railroad corridor, the SCRRA and OCTA have constructed un-engineered riprap revetment segment by segment in the San Clemente area where the railroad ballast and tracks are vulnerable to storm wave-induced damages. The revetment placement practice consists of 1) delivering rocks to the roadbed via railroad cars; 2) positioning the rocks into a uniform row alongside the roadbed with a safe distance from the tracks by tracker excavators and rubber tired end loaders; and 3) side-dumping the sloped embankment. The front-face slope of the revetment ranges between 1:1 and 1.5:1 (horizontal: vertical) downward to the beach. The crest of the revetment structure is approximately one meter above the railroad ballast to reduce wave overtopping. The riprap placement is primarily confined within the 6 to 9 meters west of the centerline of the railroad tracks.

The SCRRA has been randomly side-dumping riprap stones along the most critical segment between North Beach and the Marine Safety Building to mitigate wave-induced impacts on the railroad tracks. The maintenance practice of adding additional stones to the existing under-designed revetment has cost the SCRRA an average of $300,000 over every three-year period. The cumulative impact of stone placement over the years has been a curtailment of lateral beach access. Over the past ten years, storm wave attack in the study area has restricted train services periodically. During the 1998 El Nino, the protective revetment structure sustained severe damage that slowed down the train movement to ensure safe passage in the San Clemente area.

With the continuous shoreline retreat as anticipated, the potential of direct damage to the railroad ballast and tracks becomes highly probable, as the frequency of storm waves directly impinging upon the railroad ballast increases. The significance of transportation impacts, if the tracks are damaged by storm waves, would be similar to the prolonged service disruption resulting from the 1993 major mudslide in San Clemente. The railroad service was interrupted for 5 days during which more congestion occurred on Interstate 5, due to additional passenger vehicles and trucks. Furthermore, there exists no other economical means to deliver some commodities, such as liquefied natural gas, to the location across the boarder (e.g.Tijuana) for the essential use. Businesses receiving freight service incur higher costs to transport goods (e.g. grain, lumber, etc) that cannot be shipped by rail.

The cost to protect the tracks with additional side-dumped riprap stones will increase accordingly. Furthermore, crews will frequently be dispatched during high tide and storm conditions to visually inspect for track damage that can cause derailments. Thus, continued beach erosion along the San Clemente shoreline will lead to further disruption of rail service.

3.3 Coastal Storm Damages

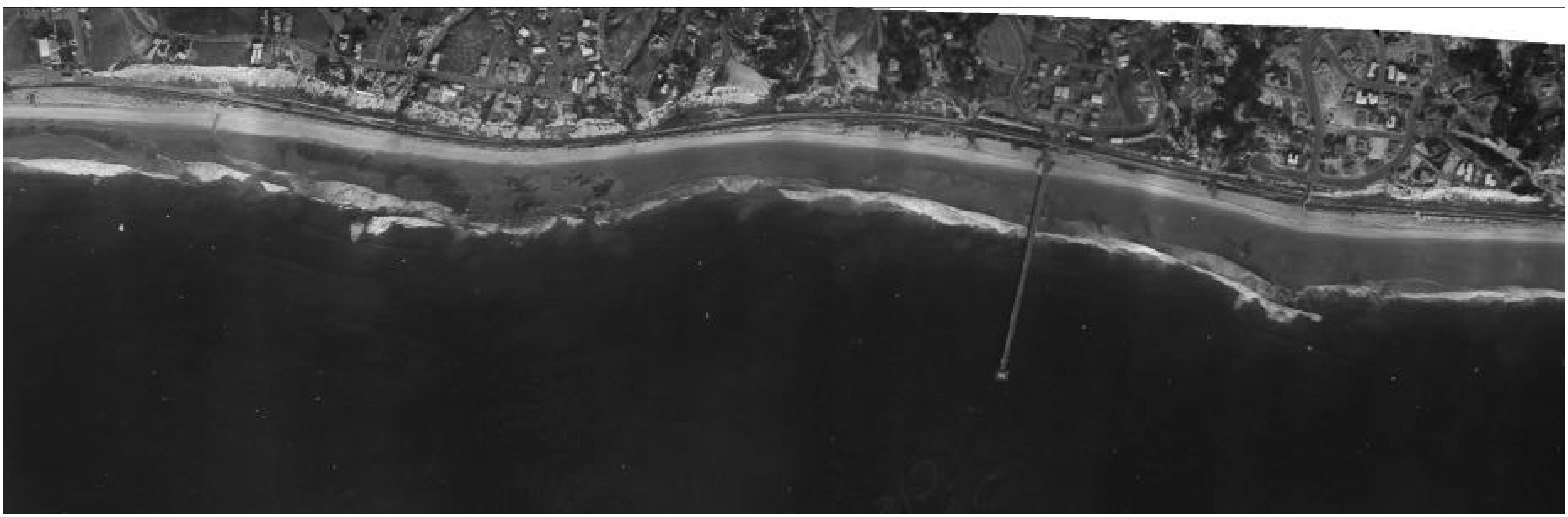
Public beach facilities primarily located in Reaches 5 and 6 include the Marine Safety Building, public restroom facilities located on the backbeach, lifeguard stations, parking areas, and paving near the pier. The beach facilities provide basic services and enhance the recreational experience for users at the City's beaches and have experienced storm damage in the past, as historically the beach width that acts as a buffer against storm wave attack has been narrow to moderate. The 1983 El Nino storm season has resulted in an estimated damage of $219,000 to coastal dwellings located landward of the railroad track and public beach facilities in the San Clemente area.

As the beach buffer that provides storm protection is further narrowed, frequent storm damages are expected to occur. Recently, an emergent sheet pile had to be installed seaward of the building to prevent the undermining of the Marine Safety Building. A similar condition that required the installation of an emergency sheet pile also occurred at a restroom located in Reach 6.

3.4 Recreational Impacts

The San Clemente Beaches are a major popular recreation venue for the region as is evident by the overcrowded attendance during peak use days (see **Figure 2-28)**. The continuing erosion of the beaches will further reduce the already limited recreational spaces on the beaches. As a consequence, the beach goers will eventually seek alternative beaches for recreational activity on other adjacent beaches in Orange County.

Furthermore, continued damages to the public facilities resulting from the shoreline retreat may require their relocation to the landward side (east) of the railroad tracks. This will require pedestrians to continually cross the tracks to use the restrooms and result in a public safety concern since many will cross the railroad tracks in an unsafe manner. Additionally, the loss of sand within the active nearshore profile has exposed underlying hard substrate and man-made structures. A public safety issue is created because the exposed material, in many cases, remains underwater and hidden from sight posing a number of potential dangers to unwary recreational swimmers. Thus, continued shoreline erosion will be detrimental to the beach recreation, resultant tourism, and economic benefits in San Clemente that has an annual tourist visitation of some two million people, approximately 60% non-residents.



Source: Corps of Enginees, Los Angeles District

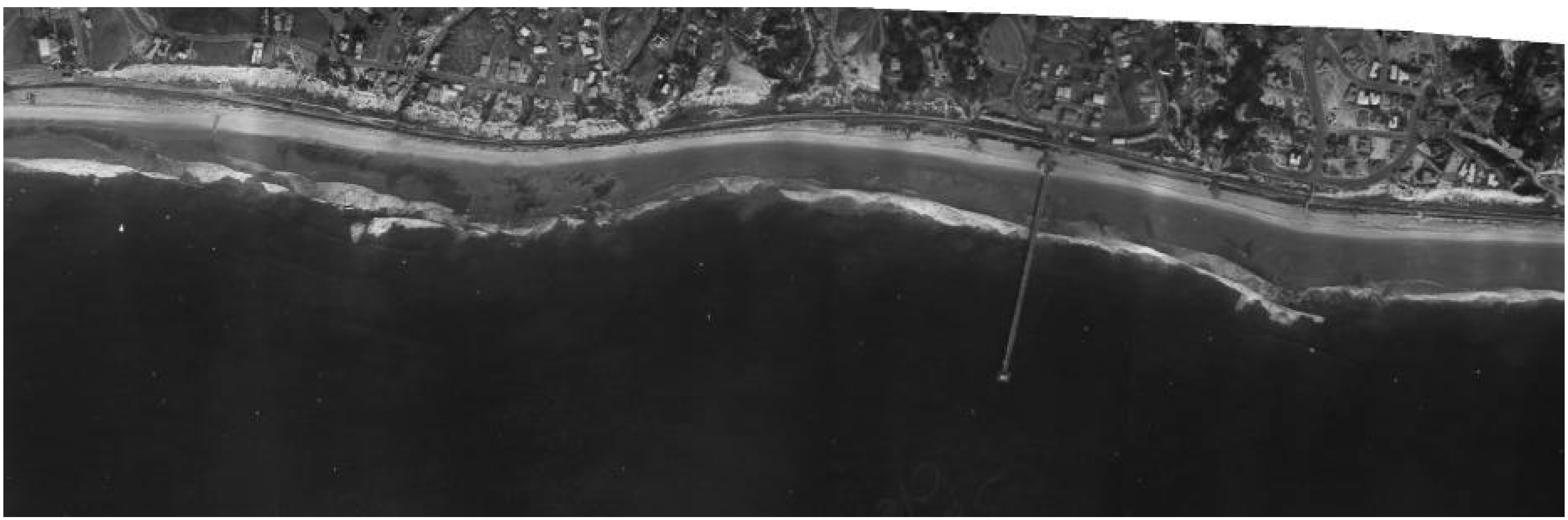
San Clemente Aerial Photograph in 1938

Figure 3-1

Note: Photograph taken in September 1960
Source: Corps of Enginees, Los Angeles District

San Clemente Aerial Photograph in 1960

Figure 3-3



Note: Photograph taken in December 1954
Source: Corps of Enginees, Los Angeles District

San Clemente Aerial Photograph in 1954

Figure 3-2

Note: Photograph taken in August 1970
Source: Corps of Enginees, Los Angeles District

San Clemente Aerial Photograph in 1970

Figure 3-4

Note: Photograph taken in September 1980
Source: Corps of Enginees, Los Angeles District

San Clemente Aerial Photograph in 1980

Figure 3-5

Note: Photograph taken in February 1983
Source: Corps of Enginees, Los Angeles District

San Clemente Aerial Photograph in 1983

Figure 3-6

Note: Photograph taken in January 1988
Source: Corps of Enginees, Los Angeles District

San Clemente Aerial Photograph in 1988

Figure 3-7

Note: Photograph taken in May 1994
Source: Corps of Enginees, Los Angeles District

San Clemente Aerial Photograph in 1994

Figure 3-8

4.0 FUTURE WITHOUT PROJECT CONDITIONS

Anticipated future without project conditions that are equivalent to the "No Action" plan for the railroad ballast and coastal structures are based upon a gradual shoreline retreating rate estimated to be 0.33 meters per year on average (see Section 3.1) and the resulting structure damage induced by various storm events for a project life cycle of 50 years starting the year of 2010. Since the Southern California Regional Railroad Authority (SCRRA) will actively protect the rail line to ensure its continuous services (McGinley, 2004), the railroad ballast will be promptly repaired upon being damaged and, if necessary, a new or re-engineered shore protective device will be constructed to protect the threatened ballast. The following sections further delineate the beach recession conditions, predicted storm damage events, and the repair scenarios likely to be conducted by the SCRRA.

4.1 Beach Recession Conditions

As previously stated in Section 3.1, the San Clemente study shoreline has been relatively quasi-stable until the early 1990's (USACE-LAD, 1991). Recently, the beach has experienced a gradual erosion trend particularly in the shoreline segment between T Street and the Marine Safety building, although a localized shoreline advance has been documented in Reach 9 (USACE-LAD, 2004). The annual shoreline change rate determined from the aggregate measured data that were collected in support of the CCSTWS (USACE-LAD, 1991) and the San Clemente beach monitoring program (City of San Clemente, 2003), ranges from +0.38 meter at Shorecliffs to -0.61 meter at T Street. The average mean shoreline retreating rate within the entire study area is 0.2 meter per year.

4.2 Model Simulation Procedures

To comply with the risk and uncertainty (R/U) policy required for this feasibility analysis, the Monte Carlo sampling technique was applied to randomly select the key oceanographic and shoreline parameters in determining the resulting damage potential to the existing railroad ballast under various storm events. The 50-year project design life begins in the year of 2010.

The reach discretization within the San Clemente study area is primarily based on the existence of a revetment protective structure or the railroad ballast only without any shore protective device. There are totally 10 discretized reaches extending from San Mateo Point to Dana Point Harbor. Reaches 1 to 9 are located within the city limit of San Clemente and Reach 10 is one of the none-incorporated districts of Orange County. The present feasibility analysis focuses on the shoreline segment located within the City of San Clemente only (i.e. Reaches 1 to 9). The inclusion of Reach 10 is strictly for discussion of the regional coastal processes within a continuous shoreline segment from the beginning of the Oceanside Littoral Cell at Dana Point Harbor to the quasi-headland of San Mateo Point. The revetment structures are present in Reaches 1, 3, 5, 7 and 9, while the shoreline features in Reaches 2, 4, 6 and 8 consist of the non-armored railroad track founded on its supporting ballast, public facilities (e.g. Marine Safety Headquarter building and restrooms) located seaward of the railroad and a municipal pier. Furthermore, the entire Reach 9 is armored with a timber seawall and further reinforced by riprap stones ranging from 5 to 7 tons that are well maintained. The anticipated damages to the landward mobile dwellings under various storm events are not expected to be significant. Therefore, this Monte Carlo simulation effort concentrates only on Reaches 1 through 8.

4.2.1 Simulation Parameters

The key parameters impacting the potential storm damage are 1) beach width, 2) foreshore slope, 3) long-term shoreline retreat, 4) water level, 5) impinging storm waves including both wave height and period, and 6) short-term storm-induced beach erosion. The Monte Carlo sampling technique allows for the random processes of storm damage events that results from various conditions of beach characteristics, long-term shoreline retreat, impinging waves, water levels, and short-term shoreline erosion. Each assigned occurrence frequency distribution from which the Monte Carlo sampling technique was applied to select the specific random parameter and is briefly described herein. The detailed delineations are presented in the Coastal Engineering Appendix.

<u>Beach Width</u>

The initial beach width varies spatially for each 50-meter cell throughout the San Clemente study area. The dry beach width was defined to be the distance from the approximate edge of the daylighted toe of the existing revetment structure seaward to the backberm elevation at +5.3 meters, MLLW. The beach width in 2010 (the project starting year) was derived from the measurement of the March 2002 Lidar survey, retreating back an additional 1.6 meters (i.e. 0.2 x8=1.6 meters) to the 2010 bench year. Since the 2002 Lidar survey was conducted in March, it can be considered to be a winter profile condition.

<u>Foreshore Slope</u>

The sampled values of the foreshore slope were developed from the foreshore slope data measured at 21 transect locations two to three times monthly for a consecutive 12 months from November 2001 to November 2002. It was determined that an extreme value distribution was the best fit to represent the probability distribution of the measured slopes, as illustrated in **Figure 4-1**.

<u>Long-Term Shoreline Retreat</u>

Based upon historical and recent beach profile surveys, a triangular probability distribution ranging from an accretion of 0.38 meter to an erosion of 0.48 meter per year was designated to represent the random behavior of shoreline change in a single modeling year. The probability distribution has a mean retreating rate of 0.33 meters and a peak occurrence at the erosion rate of 0.21 meter annually, as shown in **Figure 4-2**.

<u>Water Level</u>

The storm water level typically consists of the normal astronomical tide elevation superimposed by the storm-induced surge and setup as waves impinge onto the shoreline. The combined magnitude of the surge and setup typically ranges from 0.3 to

0.6 meters, depending on the intensity of a specific storm event. In addition, due to the global warming effect, a range of sea level rise has been quantified by various researchers. A sea level rise of 0.12 meter per year is typically used by the Corps of Engineers (National Ocean Service, 2001) for project analysis.

In this analysis, the range of the astronomical tides between +1.15 and +2.24 meter, MLLW that is uniformly distributed during a storm event was selected, and the storm-induced surge and setup with a uniform distribution between 0.3 to 0.6 meters is employed. The sea level rise of 0.12 meter, which was consistently added for each project year, superimposed to the above-mentioned uniform distributions of tides and storm surge and setup determines the storm water level. It should be noted that the peak duration for a winter storm in Southern California typically is on the order of 24 to 48 hours. For a semi-lunar tide cycle observed in the study area (i.e. two highs and two lows in a day), this implies that the peak storm-generated swells may coincide with the high tides. If it does occur, the randomly selected tide elevations may be underestimated.

<u>Impinging Wave Characteristics</u>

Nearshore wave characteristics, consisting of wave height and wave period, were compiled from wave measurements during the winter months from 1983 to 1998 at a nearshore wave gage (Station ID 052) in San Clemente. The gage is located at 33^{o} 24.9' N and 117^{o} 37.8' W and is in a water depth of 10.21 meters (CDIP, 2004). A lognormal probability distribution similar to the Beta-Rayleigh distribution applicable in the shallow water region was used for the wave height population, while a logistic distribution characterizes the range of wave period. Since the wave height distribution represents the entire wave population including storm swells, prevailing waves, and local seas, a threshold height of 2.6 meters was used to truncate the formulated normal distribution. Thus, the randomly selected storm waves should have a height equal to or greater than 2.6 meters. The threshold wave height was determined by averaging the recorded annual maximum wave height over the 16-year period. A similar approach was applied to exclude the short-period sea conditions. The truncated range for wave period is from 10 to 20 seconds. No correlation was established between a specific wave height and the associated wave period. **Figures 4-3** and **4-4** show the adapted probability distributions for wave height and period, respectively.

<u>Short-Term Storm Induced Erosion</u>

Temporary episodes of short-term winter storm erosion in addition to any natural seasonal retreat will determine the storm damage exposure for the railroad ballast and coastal public facilities. The natural season retreat within the study area typically ranges from 15 to 30 meters (USACE-LAD, 1991). However, an additional adjustment related to the season variation is not required in this analysis as the baseline beach width was derived from the 2002 Lidar survey, a winter profile condition.

Short-term storm erosion can be categorized into two components: horizontal erosion and vertical scour. The horizontal erosion for various intensities of storm events was characterized by a lognormal distribution by best curve fitting without any physical interpretation to a set of historical field measurements within the adjacent Orange County shoreline. The historical field measurements were adjusted based on the characteristics of shoreline morphology in San Clemente. The vertical scour was not directly specified in the Monte Carlo sampling simulations, but an indirect inclusion of this component was carried out by fixing the foreshore slope when the horizontal retreat of the entire beach profile occurs in responding to storm wave attack. The derived distribution of the storm-induced erosion is illustrated in **Figure 4-5**.

4.2.2 Wave Runups

Wave runup is defined as the maximum vertical elevation of wave-induced uprush against a costal protective device or on a plan beach. It is commonly used to gage the damage potential to costal development. When wave runups overtop a protective device such as revetment or seawall, the dynamic force generated from the overtopping water can scour the sediment landward of the protective device, undermine the footing and ultimately damage the structure. Since the study shoreline can be categorized into two distinguished groups of railroad ballast with an armored revetment structure and on a plan beach, respectively, two sets of empirical formulae developed from various field observations were applied to compute the wave runup elevations. These two formulae are summarily described in the Coastal Engineering Appendix, while a detailed explanation can be found in the Coastal Engineering Manual (USACE, 2003).

4.2.3 Monte Carlo Sampling

The Monte Carlo sampling randomly selected each above-mentioned key parameter in accordance with the associated probability distribution function, and subsequently wave runups were computed for the storm damage assessment to the railroad ballast and coastal development. Past field observations indicate that the minimum incremental segment of storm damage is on the order of approximately 50 meters. Therefore, the simulation is on a cell-by-cell basis with a 50-meter individual cell length. The entire study area from Reach 1 to Reach 8 is divided into numerous 50-meter cells. The sampling procedure for each simulated cell in a specific simulated year starting in 2010 is briefly itemized and discussed as follows.

1) Determine the dry beach width for the simulated year based on the 2002 Lidar survey and the cumulative mean long-term erosion from 2002 to the year of interest;
2) Randomly select a foreshore slope that is identical for all cells;
3) Determine the storm water level from randomly selected astronomical tide, surge, and setup that are to be superimposed to the accumulative sea level rise;
4) Randomly select storm wave characteristics including wave height and the associated period, based upon the assumption that only one storm event occurs in a single year;
5) Select a storm-induced erosion distance corresponding to the intensity of the selected storm; and finally
6) Compute wave runups depending on the type of the railroad ballast condition.

The single simulation continues for the 50-year project design life starting in 2010 and ending in 2060. The output from an individual Monte Carlo sampling simulation will have a set of wave runup elevations with one estimate for each individual cell in a specific simulated year.

4.3 Forecasted Storm Damages

As previously stated in Chapter 2, coastal development within in the San Clement study area, which is potentially impacted by winter storm wave attack, consists of the SCRRA railroad ballast and public facilities of Marine Safety Building, Municipal Pier, concession stands, and restrooms. The railroad ballast extends throughout the entire study area, while public facilities exist primarily in Reaches 5 and 6. Storm-induced wave impacts against the coastal development can be categorized into 1) structure damage due to direct wave dynamic forces against the structures; and 2) rail traffic service delay resulting from wave overtopping. Loss of recreational beach and narrowing of the dry beach buffer against wave attack are also anticipated as a consequence of the projected long-term shoreline retreat.

4.3.1 Railroad Ballast

The revetment structures were built in Reaches 1, 3, 5, and 7 by the SCCRA to protect the railroad ballast. The remaining reaches of the railroad line (Reaches 2, 4, 6 and 8) consist of the non-armored railroad track founded on its supporting ballast. Structure damages upcoast of North Beach (i.e. Reach 9) are not considered in this analysis, as the railway is located landward of coastal dwellings that are armored with a protective revetment structure.

Railroad ballast damages induced by wave impact forces occur when storm waves impinge directly against the structure. The degree of impact loading is a function of the runup elevation and the resistant capability of the ballast structure. An empirical correlation was established to quantify the percentage of the ballast damage for various wave runup elevations. **Table 4-1** shows the degree of the ballast damage in relation to the height of wave runup. It is noted that the crest elevation of the ballast revetment is at

Table 4-1: Ballast Damage Functions

Runup Elv. m (ft)	Percent Damage for Ballast without Armored Revetment	Percent Damage for Ballast with Non-Engineered Revetment
0	0	0
3.05 (10)	0	0
3.66 (12)	1	0
4.27 (14)	5	0
4.88 (16)	10	1
5.49 (18)	15	5
6.10 (20)	20	10
7.62 (25)	25	15

+6.9 meters, MLLW and the elevation of railroad track is at +6.3 meters, MLLW. The damage functions are similar in concept to the percent damage and no-damage criteria provided in the Shore Protection Manual (SPM) (USACE-CERC, 1984). A distinction was made between the ballast only (no protection) and the railroad with an armored non-engineered revetment. The two damage functions were calibrated against the historical damages that were experienced by the SCRRA in the past.

Previous discussions with the SCRRA indicate that the agency is required to proactively protect the rail line in order to avoid and minimize any possible service disruption. Therefore, it is improbable that the future damage to the railroad ballast and tracks would continue without a prompt repair/mitigation measure implemented by the SCRRA. Based on further consultations with the SCRRA and the City of San Clemente (City of San Clemente, 2004), the probable response by the SCRRA for the future potential damage to the railroad infrastructure would be to upgrade the existing revetment on a cell-by-cell basis and to construct a new seawall structure for those reaches with no armored revetment. A detailed description is provided as follows.

The current practice of the SCRRA consists of side-dumping riprap stones on the existing revetment structures or the ballast-only reaches on a cell-by-cell basis. Each cell has a defined length of 50 meters. Based on the project meeting on May 6 and the special requirement imposed by the California Coastal Commission (CCC) dated May 23, 2003 (CCC, 2003), the new multi-year maintenance permit being requested by SCRRA implies that the side-dumping practice is no longer a valid measure. The SCRRA authority will not be allowed to continue side-dumping rocks for repair or maintenance purposes.

For those reaches armored with a shore protective revetment, an engineered upgrade of existing revetment is assumed in each 50-meter revetment cell whether the revetment structure is deemed necessary from a maintenance viewpoint or is damaged by storm-induced wave overtopping. However, for the ballast-only reaches, the entire reach will be armored with a new, engineered seawall when the cumulative total of one-third of the cells in the reach is damaged. Emergency measures to repair each 50-meter damaged cell are necessary until the total damages exceed one-third of the total cells in the reach. It is probable that an emergency repair may be applied to the damaged cell prior to the comprehensive upgrade or construction of a newly designed seawall during a severe storm event.

A vertical seawall is constructed of poured in-place concrete with internal steel rebar reinforcement and is typically founded in bedrock. Since the seawall reflects and amplifies the impinging wave energy, the seawall structure built along the unimproved ballast areas would typically be higher than the elevation (say +7 meters, MLLW) of the presently un-engineered revetment segment since it must be constructed to resist the full wave force. A toe apron protection to the seawall may be required. A representative cross section of the seawall without a toe apron is illustrated in **Figure 4-6**.

With the defined ballast and revetment damage functions, the Monte Carlo sampling simulations to account for the uncertainty of the above-identified key parameters were carried out to estimate the total repair/ maintenance cost over the 50-year project design life under the future without project conditions. Typically, 600 to 700 simulations were required to achieve the cost convergence criterion of 1.5 percent.

The resultant costs (i.e. present value in 2010) for the above-identified repair/ maintenance of the existing revetment (Reaches 1,3 5, and 7) and the construction of a new seawall of the unprotected ballast (Reaches 2, 4, 6, and 8) is presented in **Table 4-2**. The estimated costs include both the initial construction, and subsequent operation and maintenance (O&MN). The estimate was based on the unit cost presented in **Table 4-3**. It should be noted that the cost estimate does not include 1) additional expense for the emergency response and 2) economic loss of the interruption or delays of railroad services.

Table 4-2: Resultant Cost for Repair, Maintenance & New Construction Under Various Scenarios

Reach Segment	Reach Length (m)	Estimated Cost ($)
Reach 1	3,178	906,943
Reach 2	2,230	2,596,069
Reach 3	1,968	821,191
Reach 4	2,401	1,250,149
Reach 5	1,355	582,064
Reach 6	3,411	10,585,150
Reach 7	3,546	1,600,678
Reach 8	1,138	2,267,310

Table 4-3: Unit Cost for Construction and Operation & Maintenance

Cost Item	Cost per 50-meter cell ($)
Upgrade of Existing Revetment	32,800
O & MN of Existing Revetment	2,173
Initial Construction of Revetment	98,400
O & MN of New Revetment	984
Initial Construction of New Seawall	492,000
O & MN of New Seawall	4,920
Mitigation cost for Loss of Sand Supply	3,608
Mitigation Cost for Loss of Public Access	39,360

4.3.2 Existing Coastal Structure

4.3.2.1 Public Facilities

It is noted that studies are still underway to assess the damage potential to the above-identified beach facilities. Nevertheless, preliminary description of this damage is described as follows. The facilities listed in Table 2-17 are expected to experience damages during coastal storms. Some protective devices have already been placed to many of the structures to minimize damages during storm events. It is expected that under without project conditions the State and City will continue to maintain these structures and repair any damages caused by storms, until such time erosion of the beaches will reach a point where recreation use of the beach will be severely limited. A preliminary estimate of damage potential is based on selecting that period of time when the facility will no longer be needed, and it is likely that damage from coastal storms will result in complete loss of the facility. (This does not include potential frequent damages and repairs that may occur while the recreation beach is still available). At this time it is assumed that recreation beach will be lost by the year 2020, and there would be a total loss of all beach facilities as well. Thus, the total loss of public facilities would be valued at $1,475,000. Based on this assumption, the equivalent average annual damages are estimated to be $59,500.

4.3.2.2 Pier Access Pavement

The San Clemente Municipal Pier is a popular recreational facility for sport fishing, dining and other leisure activities. The Pier itself is located on timber piles with a deck elevation at +7.2 meters, MLLW at the beginning section. Potential damages to the Pier structure itself is not related to continued beach erosion, although it can be damaged as a result of direct wave impingement against the deck, as is evident in the 1983 El Nino season. However, access to the Pier is a paved area at beach grade and is vulnerable to being undermined from beach erosion and damaged from major storm events. Consequently, it is expected that at such time that access to the pier becomes jeopardized and improvements will need to be made to maintain the Pier access. The occurrence of this damage potential and the associated repair cost or necessary improvements will be further delineated in the F4 report.

4.4 Recreational Loss

The recreational loss associated with the long-term shoreline retreat was estimated from a simplified method that quantifies the economic loss due to the reduction of beach area over years as a result of continuing shoreline retreat. The following presents a simplified method to derive a preliminary estimate of potential beach benefits from restoring the recreation beach.

The major assumptions used in this analysis are:

a. The capacity of the beaches for recreation users to receive full unit day value is 9 m^2 (100 square feet);

b. A peak day turnover factor of three is applied to capacity to determine total daily visitors (based on Phil King interviews);

c. An assumption of the number of peak days per year that the capacity will be exceeded (assumed to be about 100 including 3 months of summer and late May early September);

d. A unit day value for the recreation use of $8.00 per visitor. (Approximate full unit day value based on Phil King's report).

e. Estimates are developed for base year in 2010, and 50th year in 2060 based on changes in beach area due to erosion, which impacts the full capacity estimates.

The difference between year 2010 and 2060 is the total change in values due to erosion. Average annual is based on mean of the two extremes. **Table 4-4** shows current beach width and available area for each reach, and reductions expected over the next 50 years based on an average erosion rate of 0.33 meters per year. The table also provided the estimated user capacity for recreational activity in accordance with the above-mentioned assumption. The average annual value of recreational beach loss over the 50-year project life cycle was estimated to be $5,111,200 for the entire study (i.e. Reaches 1 to 9). The estimate was based on 100 peak days per year, daily turnover rate of 3 and a unit day value of $8.

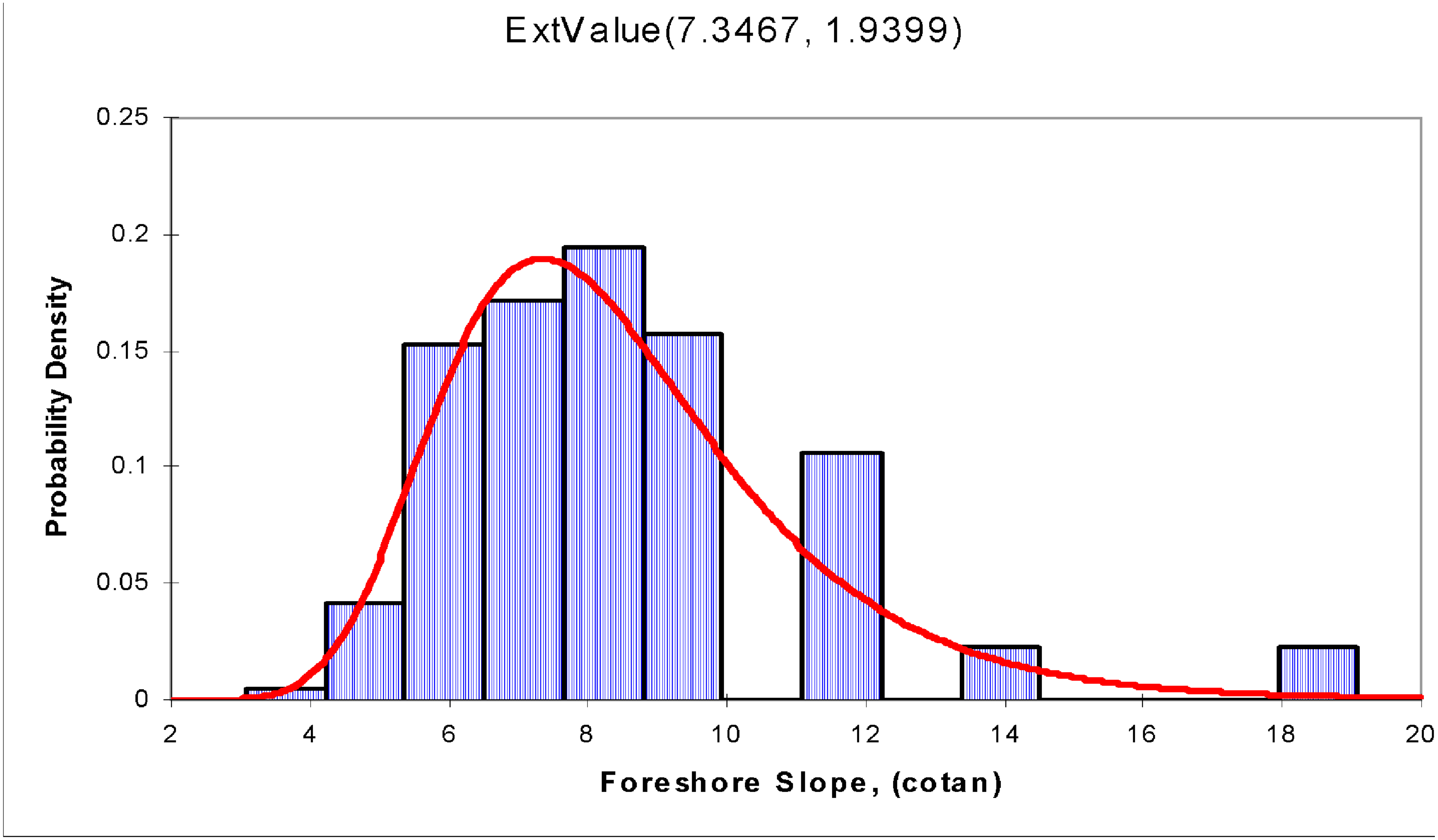
Table 4-4: Recreational Capacity on Study Beach By Reach

Reach	Length (m)	Width in 2010 (m)	Beach Area (m^2)	Estimated Capacity (persons)	Width in 2060 (m)	Beach Area (m^2)	Estimated Capacity (persons)
1	969	0 to 41	15,356	1,653	0 to 24	12,120	1,305
2	680	9 to 41	14,196	1,606	0 to 24	11,398	1,227
3	600	0 to 9	709	76	0	0	0
4	732	0 to 60	10,718	1,153	0 to 43	6,985	752
5	413	0	0	0	0	0	0
6	1,040	0 to 39	5,380	579	0 to 22	2,113	227
7	1,081	0	0	0	0	0	0
8	347	0 to 40	3,327	358	0 to 23	1,878	202
9	1,101	0	0	0	0	0	0
Total	6,690	-	50,408	5,426	-	34,494	3,713

A comprehensive evaluation is being accomplished by Phil King and the Los Angles District Economics staff. This includes a more detailed analysis of 1) attendance and changes in recreation demand on a reach-by-reach basis; 2) recreation activities including general recreation and surfing during the high and low season; 3) the values of the different recreation uses over time; 4) consideration of users transferring to other beaches; and 5) the impact of continued erosion as well as restoring the beaches by reach. The Economics Appendix includes a portion of this analysis. The complete analysis will be presented in the F4 report.

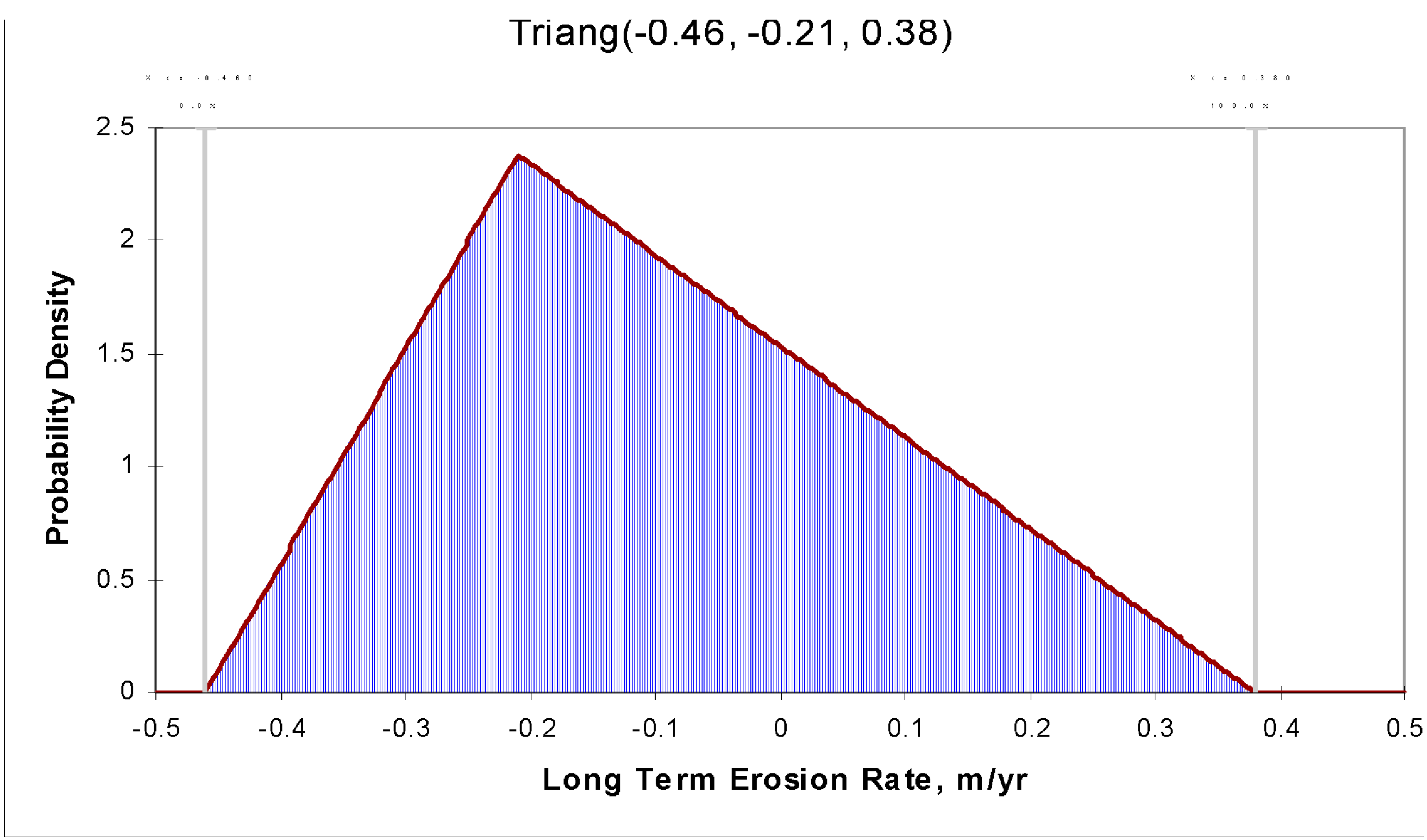
4.5 Potential Environmental Consequence

Under future without project conditions, shoreline environmental conditions are not expected to alter significantly. There may be some additional loss of sandy beach habitat as the continuing shoreline retreat occurs. There would be no potential impacts on marine habitats such as plankton, vegetation, fish and wildlife, threatened endangered species as well as onshore and offshore culture resources.



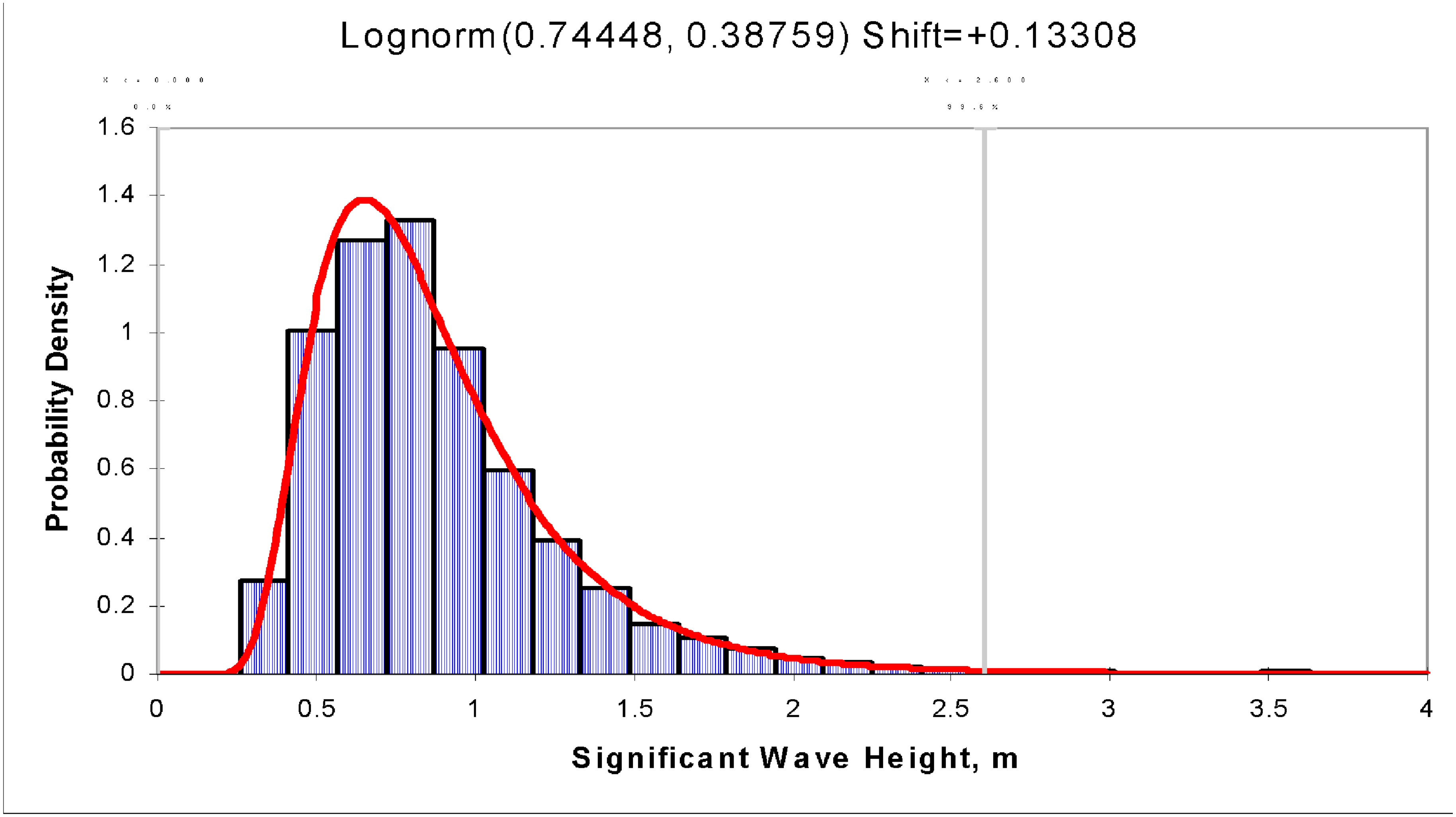
Foreshore Slope Probability Distribution

Figure 4-1



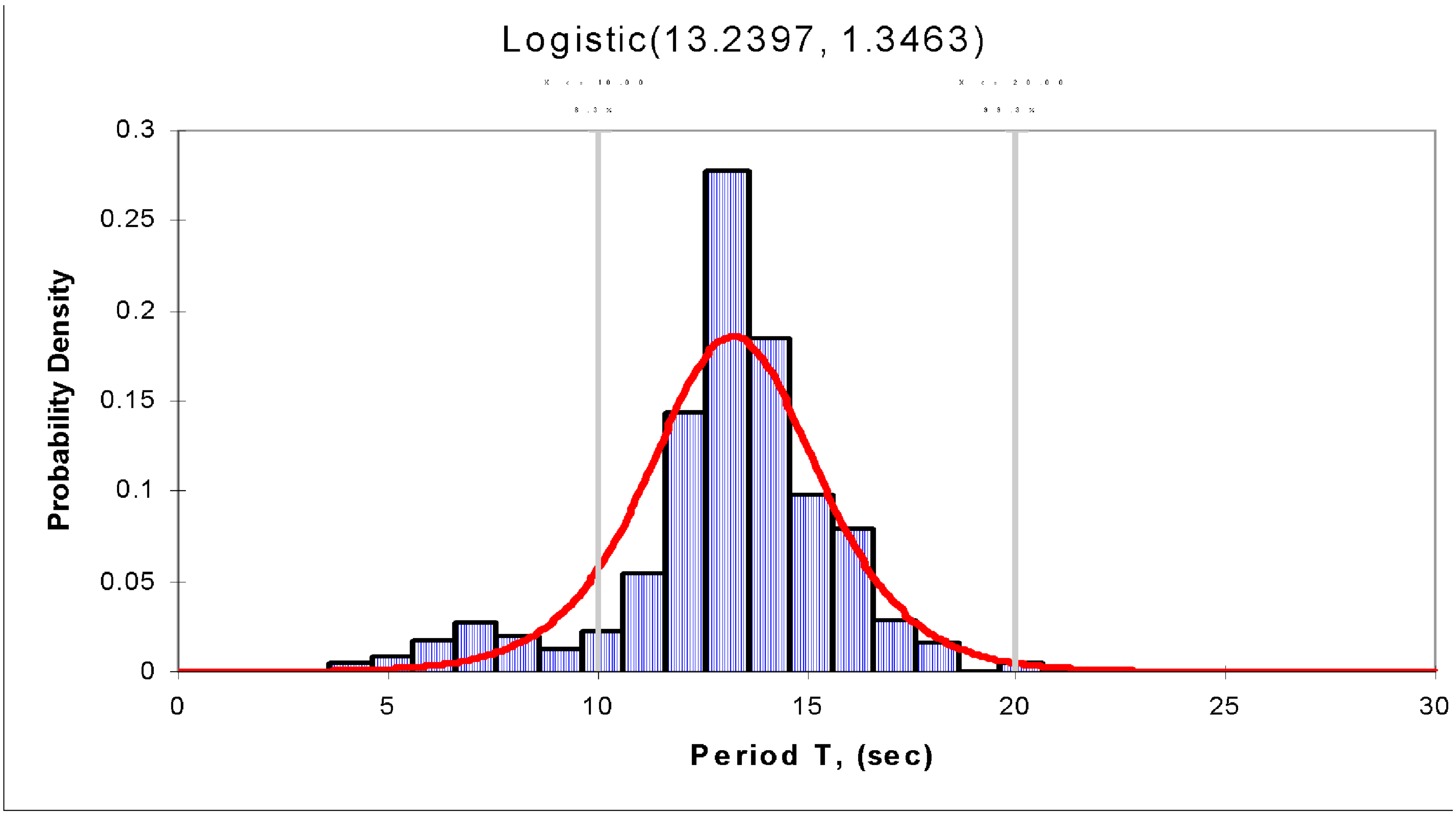
Long-Term Shoreline Retreat Probability Distribution

Figure 4-2



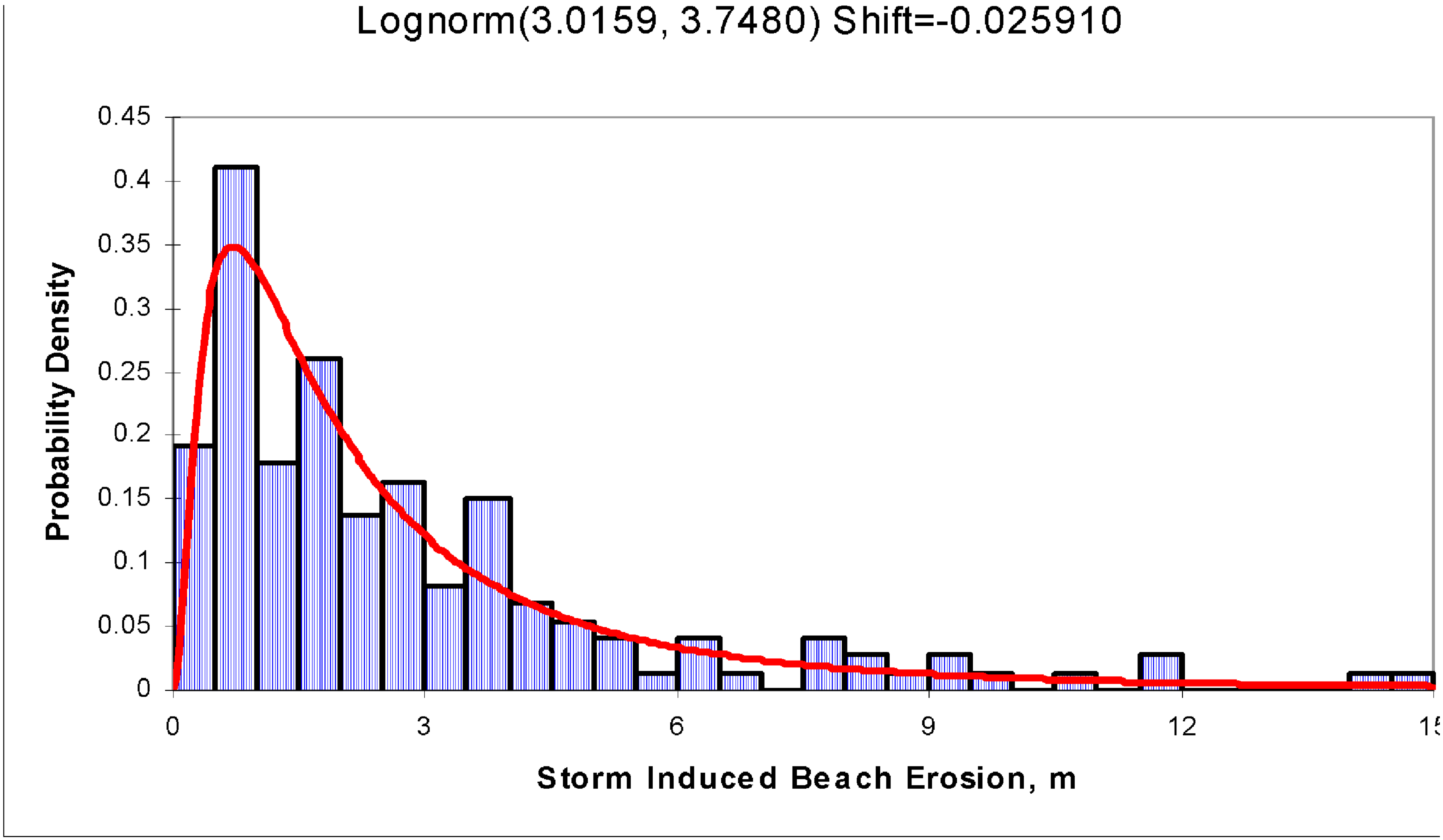
Significant Wave Height Distribution

Figure 4-3



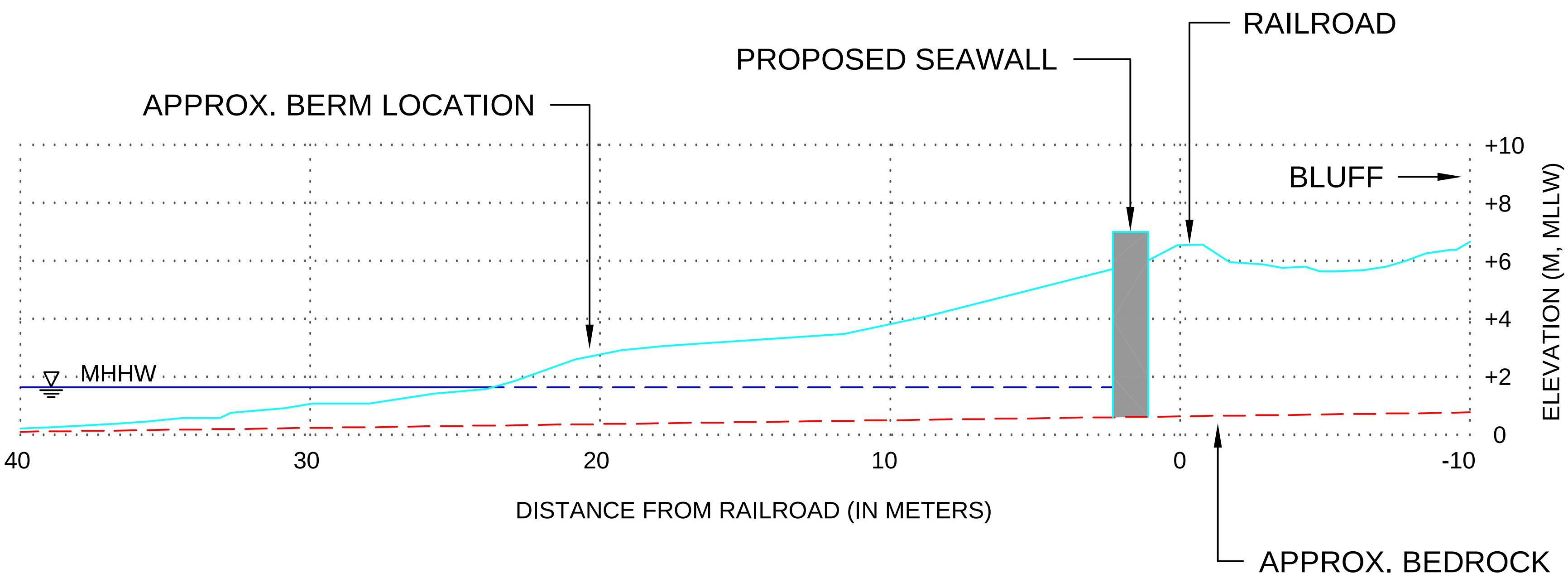
Peak Wave Period Probability Distribution

Figure 4-4



Short-Term Storm Erosion Probability Distribution

Figure 4-5



Beach Profile with Seawall

SCALE: 1 INCH = 6 METERS

Figure 4-6

5.0 PLAN FORMULATION

This Chapter presents the results of applying the plan formulation process leading to selection of a recommended plan. The process was accomplished in accordance with the Water Resources Council's "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies," dated March 10, 1983, which establishes the procedures for formulating Federal water and related land resource projects. The Corps of Engineers procedures for complying with the Principles and Guidelines are presented in Engineering Regulation (ER) 1105-2-100, "Planning Guidance Notebook", dated 22 April 2000. The plan formulation process includes the establishment of planning objectives and constraints, and evaluation criteria; the development of alternative plans; assessment of costs, benefits, and impacts associated with the alternative plans; the evaluation of alternative plans including trade-off analysis between alternatives; identification of the National Economic Development Plan and National Environmental Restoration Plan, locally preferred plan, and selection of a recommended plan.

5.1 Planning Objectives And Constraints

The first step in the planning process involves establishing the planning objectives that are desired to be achieved as a result of any proposed plan. It also includes identifying planning constraints and evaluation criteria to be used in the formulation of alternatives and in the evaluation process. The steps involved in establishing the planning objectives include identifying the public concerns to be addressed in the study, and analyzing the existing and future without project conditions in the study area to identify and define the scope and magnitude of problems, needs and opportunities associated with the water resource conditions and uses in the study area.

5.1.1 National Objectives

The national or Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statures, applicable executive orders, and other Federal planning requirements. Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

The Corps has added a second national objective for Ecosystem Restoration in response to legislation and administration policy. This objective is to contribute to the nation's ecosystems through ecosystem restoration, with contributions measured by changes in the amounts and values of habitat.

5.1.2 Public Concerns

A number of public concerns have been identified during the course of the study. Input was received through coordination with the sponsor, coordination with other agencies and through a public workshop held in January 2002. A discussion of pubic involvement is included in Chapter 8, Public Involvement, Review and Consultation. The public concerns that are related to the establishment of planning objectives, planning constraints, and establishment of evaluation criteria are:

- Desire to reduce the potential for storm damages to the LOSSAN Rail Corridor rail facilities and rail line operations, located along the beaches of the City of San Clemente;
- Desire to reduce the potential for storm damages to public beach facilities;
- Desire to restore the recreation beach area along the Pacific Coast of the City of San Clemente;
- Desire to preserve the near shore ecosystem that supports commercial lobster, fisherman, and snorkeling activities;
- Desire to preserve and enhance opportunities for surfing along the San Clemente coast;
- Desire to maintain the aesthetic characteristics of the coastal area of the City of San Clemente;
- Desire to improve public access and safety to the recreation beach areas of the City of San Clemente;

5.1.3 Planning Objectives

The national objectives are general statements and not specific enough for direct use in plan formulation. The water and related land resource problems and opportunities identified in this study as presented in Chapter 3, and public concerns noted above are stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent the desired positive changes in the without project conditions. The planning objectives are specified as follows:

a. Reduce the potential for storm damages to facilities located along the coast of the City of San Clemente including recreation beach facilities and the LOSSAN Rail Corridor; and

b. Restore and maintain recreation use along the Pacific Coast of the City of San Clemente;

5.1.4 Planning Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. The constraints identified include those public concerns that if violated by an alternative plan would result in the plan not being acceptable to most public interests. It also includes those aspects of the study area generally regulated by government agencies that if adversely impacted would result in the plan being unacceptable. In general, the planning process needs to consider measures to avoid or mitigate any significant adverse impacts associated with the planning constraints. The planning constraints identified in this study are as follows:

a. Preserve the nearshore ecosystem that supports commercial lobster, fishing industries, and snorkeling activities;

b. Preserve the opportunities for surfing along the Pacific Coast of the City of San Clemente;

c. Preserve any critical habitat that supports Federal or State threatened and endangered species;

d. Preserve water quality characteristics along the coast and near shore areas of the City of San Clemente;

e. Preserve cultural and historic features located in the Study area;

f. Preserve air quality conditions within the study area.

5.1.5 Evaluation Criteria

The evaluation criteria to be applied in later sections of this Chapter consist of those criteria established by the Water Resources Council's Principles and Standards, Corps of Engineers planning guidelines, and other criteria established by Federal law. The criteria also includes those items considered important to the local sponsor and public interests that should be evaluated as part of the decision making process. A list and description of evaluation criteria to be applied in the decision making process are summarized below.

a. Water Resources Council - Required four systems of accounts to display the assessment and evaluation of potential changes that can be expected from alternative plans.

1. National Economic Development – Displays the changes in the economic value of the national output of goods and services.

2. Environmental Quality – Displays non-monetary effects on ecological, cultural, and aesthetic resources.

3. Regional Economic Development – Displays changes in the distribution of regional economic activity, e.g. income and employment.

4. Other Social Effects – Displays plan effects on social aspects such as community impacts, health and safety, displacement, and others.

b. Water Resources Council – The final array of alternative plans are compared using four formulation criteria suggested by the U.S. Water Resources Council. These criteria are completeness, effectiveness, efficiency, and acceptability.

1. Completeness. Completeness is a determination of whether or not the plan includes all elements necessary to achieve the objectives of the plan. It is an indication of the degree that the outputs of the plan are dependent upon the actions of others.

2. Effectiveness. All of the plans in the final array provide some contribution to the planning objectives. Effectiveness is defined as a measure of the extent to which a plan achieves its objectives.

3. Efficiency. All of the plans in the final array provide net benefits. Efficiency is a measure of the cost effectiveness of the plan expressed in net benefits.

4. Acceptability. All of the plans in the final array must be in accordance with Federal law and policy. The comparison of acceptability is defined as acceptance of the plan to the local sponsor and the concerned public.

c. Corps of Engineers criteria. Consistent with the Water Resources Councils criteria, the Corps basic criteria to determine feasibility of a plan are:

1. Engineering Technical feasibility - Projects must be functional and complete recognizing state of the art design and construction methods;

2. Environmental impacts -- environmental acceptability must be ascertained; adverse impacts should be avoided if possible, or minimized, if avoidance is not possible;

3. Economic justification in accordance with current guidelines and policies. Benefits must, at a minimum, equal the costs of a project. Ideally, benefits clearly outweigh costs; the alternative with the highest net benefits is selected as the National Economic Development (NED) Plan, and is generally selected as the Recommended Plan, unless there is an overriding reason to select another alternative;

4. Acceptability from the general public and the non-Federal sponsor;

d. Local concerns and criteria. Based on coordination with local sponsor, other agencies and interests, and comments received at the public workshop, several concerns that will be applied in evaluating the alternatives include:

1. Impacts of revetment and seawalls. Concern was expressed on the impacts of revetment and seawalls on exacerbating erosion.

2. Consider aesthetics. An interest expressed the need to consider aesthetics as part of evaluating alternative plans.

3. Consider impacts to local businesses and community. The study should consider the impacts of continued erosion and loss of the recreation beaches and the benefits of restoring the beach on local businesses and the community.

4. Surfing is critical to the community culture of San Clemente. It was noted that the City of San Clemente was one of the centers of developing California's surfing interest, and there are numerous organizations and businesses that support this activity.

5. Consideration of public safety and public access. It was noted that the existing rail line limits access to the beach and causes major public safety concerns. This should be addressed as part of the study.

6. Rail line relocation. There has been some discussion regarding the possible relocation of the rail line as part of future high-speed rail or double track improvements. However, there are no plans or funds in place at this time. The evaluation of alternative plans should not consider this possibility and the differences of impacts if the rail line is or is not relocated in the future.

5.2 Alternative Plans– Initial Screening

The next step in the formulation process is to develop viable alternative plans. The process in developing the viable plans involves several iterations of developing and screening alternative management measures and plans. Alternatives to address the reduction of potential storm damages are developed considering different scopes of plans by varying levels of protection such as protecting only against frequent minor storm events as compared to protecting against the less frequent major storm events. Consideration is also given to protecting certain reaches of the study area as compared to several reaches or the entire study area. For the planning objective involving restoration of beach area for recreation use, consideration is also given to different levels of restoration involving very wide beaches that may only be needed on the highest peak use days, as compared to narrower beaches that are needed for the more frequent peak use days. Alternatives for this objective are also looked at by study reach, where some reaches may have minimal use for recreation. Screening of these alternatives will consider much of the evaluation criteria stated above including economic costs and benefits, environmental impacts, and significant impacts to the planning constraints. Mitigation measures to avoid or minimize these impacts will be incorporated into the alternative plans as necessary. This development and screening process will lead to an identifying set of final alternative plans that will be examined in detail using the system of accounts and tradeoff analysis such that decisions can by made on the best plans from NED standpoints, EQ standpoints, and a locally preferred standpoint. From these plans, a plan will be selected for recommendation to Congress for authorization.

5.2.1 No Action

The Corps is required to consider the option of “No Action” as one of the alternatives in order to comply with the requirements of the National Environmental Policy Act (NEPA). With the No Action plan, which is synonymous with the “Without Project Condition,” it is assumed that no project would be implemented by the Federal Government to achieve the planning objectives. The No Action Plan forms the basis which all other alternative plans are measured against. Since this plan is required by NEPA to be included among the candidate plans in the final array of alternatives, it is described in more detail in the final alternative plans of this chapter. For the purposes of the initial screening, the No Action Plan is based on the SCRRA’s maintenance plan to the potential damage to the railroad ballast and tracks as previously addressed in Section 4.3.1, but without any measures implemented by the City of San Clemente for the continued erosion and recreation beaches along the entire coast of San Clemente.

5.2.2 Alternative Measures

An alternative measure is a feature or activity at a site, which address one or more of the planning objectives. A wide variety of measures were considered, some of which were found to be infeasible due to technical, economic, or environmental constraints. Each measure was assessed and a determination made regarding whether it should be retained in the formulation of alternative plans. The descriptions and results of the evaluations of the measures considered in this study are presented below:

<u>Non-Structural.</u> In general non-structural measures that would provide positive contributions to the planning objectives are:

a. Reducing Potential Storm Damage

- Managed retreat of coastal development including relocation of the railroad and beach facilities. At this time, most of the public beach facilities are located along the backshore in Reach 6. Continued erosion and storm wave attack will likely eliminate any beach area available for recreation use and accordingly the facilities may no longer be needed or minimal facilities such as restrooms being relocated to the landward side of the railroad. The relocation of the railroad is extremely costly and any decision for such relocation is beyond the scope and intent of this study. In this regard it is noted that as part of the no action plan, it is expected that the railroad will continue to upgrade the existing revetment in Reaches 1, 3, 5 and 7 and to construct new seawalls in Reaches 2, 4, 6 and 8 to avoid storm damage to its facilities and its operations. Accordingly managed retreat will be considered only to the extent that it may be included as part of the no action plan or without project condition.

-Flood proofing of structures by raising or protecting structures from storm waves and runup and continued erosion. Similar to managed retreat, the City of San Clemente has already taken some actions to protect its facilities from storm damage. However, eventually the erosion of the beaches will require relocation of some facilities and elimination of others. These measures will be examined further only to the extent of defining actions to be taken as part of the no action plan or without project condition.

b. Restoration of Beach Area for Recreation

-Managed retreat of recreation uses. As erosion of the recreation beach area continues, it is expected that beach use for most recreation activities will be eliminated. Eventually the beach area will be completely lost with the backshore area being fixed by revetment or seawalls placed by the railroad. Some activities such as surfing will likely continue although the quality of the experience would be reduced causing a reduction in the number of visitors. Again, this managed retreat is likely to occur to some degree and will be further defined under the no action plan or without project condition.

-Transfer of beach users to other beaches. Similar to managed retreat, it is expected that as erosion continues, recreation beach users will use other available beaches that have sufficient capacity to accommodate increases in the number of visitors. This will be further defined in describing the no action plan or without project condition.

<u>Structural.</u> Structural measures that would also provide positive contributions to the planning objectives similar to the non-structural measures are:

a. Reducing Potential Storm Damage

-Revetment. This measure consists of placing riprap or building a rubblemound structure to prevent further landward erosion and the coastal development from being exposed to storm wave attack. This measure is already being used to protect rail ballast and tracks in Reaches 1, 3, 5 and 7. The revetment alternative would include the construction of new revetment structures for the remaining un-armored reaches (i.e. Reaches 2, 4, 6, and 8).

-Seawalls. The seawall alternative measure, which typically requires less area and maintenance, includes removal of existing revetment structures in Reaches 1, 3, 5 and 7 and construction of new seawall structures for all 8 reaches (i.e. Reaches 1 to 8).

-Beach Fills. The restoration of protective beaches can provide protection to railroad facilities and operations as well as the beach facilities. This measure will be carried forward into the development of alternative plans. The beach fill alternative consists of three options: 1) Beach fills without any hard structure; 2) Beach fills with hard structures, such as artificial reefs (emergent or submerged) to preserve the nearshore rock marine habitat and to enhance surfing conditions; and 3) Beach fills with hard structures to prolong the sand replenishment cycle. The type of hard structures is further delineated in the following additional measure section.

-Breakwaters. Nearshore or offshore breakwaters are built seaward of the breaker line parallel to the shoreline to provide dual purposes of protecting shore areas from direct wave action and of trapping littoral sand on landward beaches along the San Clemente shoreline. However, the cost of breakwaters is extremely high as compared to the other measures, and impacts to the area aesthetics, ecosystem, and surfing would be substantial. Accordingly, the use of breakwaters to provide storm damage protection is eliminated.

a. Restoration of Beach Area for Recreation

-Restore historic beach areas. The only structural measure to restore and maintain recreation use of the San Clemente beaches is to renourish the beaches (i.e. beach fills). This measure can also be designed to provide protection to backshore development and uses. Accordingly, the restoration of beach area will be carried forward in developing alternative plans.

<u>Additional Measures.</u> The restoration of a protective beach or restoration of historic beach areas for recreation will require additional measures to maintain the restored conditions due to the continuous impact of erosion. Measures to be considered to maintain the restored beaches or reduce erosion of the restored beaches include:

-Periodic beach nourishment. The periodic renourishing of protective and recreation beaches is viable and will be examined as part of developing alternative plans.

-Groins. The construction of small-scale groin structures can be used to reduce erosion of the restored beaches. These measures, if properly designed, can function to minimize any downcoast impacts and impacts to surfing. This measure is unlikely to be acceptable to many interests but further consideration may be given to assure there would not be any significant reduction in costs to maintain the restored beaches with this measure.

-Nearshore Breakwater or Artificial Reefs. The placement of nearshore breakwaters or artificial reefs, whether they are submerged or emergent, is to reduce the replenishment cycle after an initial beach fill and to enhance recreational surfing activity, if applicable. Thus, it is considered as a supplemental measure to accommodate the beach fill alternative. They can also be designed to enhance wave conditions for surfing interests. This measure may be further considered in developing alternative plans.

-Vegetation. Certain types of vegetation can be used to reduce erosion of restored beaches. In general this measure could be considered in those reaches with minimum public use, and potential for ecosystem type of benefits. This measure is not further considered, as it will significantly reduce the available recreational area on beach.

-Submerged nearshore berm. This measure consists of placing an offshore sandy berm that could reduce wave attack as well as provide nourishment to beaches by onshore movement. The cost of this feature is likely to be significantly high, and potential impacts to surfing and nearshore ecosystems will be significantly adverse. Accordingly, this measure will no longer be considered for this study area.

b. Summary of viable measures.

The viable measures that can be implemented to reduce potential storm damages and/or to improve recreational activity are revetments, seawalls and beach fills with or without the supplemental hard structure measure. The revetment and seawall alternatives can only provide the storm damage protection, while the beach fill alternative will also enhance beach recreation.

5.2.2.1 Design Criteria

The analysis of coastal conditions in the study area leads to defining specific criteria to be used in designing alternative measures to reduce storm damage in the study area. The oceanographic criteria, the characteristics of beach morphology, and the resulting wave runups and impact forces that are detailedly described in Section 4.2.1 are used to determine the required design features for the selected alternative measures.

5.2.2.2 Revetment Alternative

The reaches within the San Clemente study area are primarily based on the existence or non-existence of a revetment protective structure along the railroad track ballast. There are 10 discreet reaches extending from San Mateo Point to Dana Point Harbor. The revetment structures are present in Reaches 1, 3, 5, 7 and 9, while the shoreline features in Reaches 2, 4, 6 and 8 consist of the non-armored railroad track ballast. There are several public facilities (e.g. Marine Safety Headquarter building and restrooms) located seaward of the railroad and a municipal pier. The revetment alternative consists of upgrading of the existing revetment in Reaches 1, 3, 5, and 7 and constructing new revetments in Reaches 2, 4, 6 and 8. The design cross-section of the both upgraded and newly constructed revetment structure is shown in **Figure 5-1**.

5.2.2.3 Seawall Alternative

The seawall alternative includes removal of the existing revetment structures in Reaches 1, 3, 5, and 7, and construction of a new seawall extending from San Mateo Point in Reach 1 to Pico in Reach 8. The length of the seawall for each reach would be similar to the dimension applied to the revetment structure. The typical seawall section in relation to the fronting beach and railroad tracks and ballast is illustrated in **Figure 4-6**.

5.2.2.4 Beach Fill Alternative

The design feature of a beach fill is based on providing storm damage protection and that includes a berm crest at +5.3 meters, MLLW, beach width of 30 meters, and foreshore slope of 15:1 (horizontal: vertical). The initial beach to be placed includes an additional beach width of 20 meters for advanced periodic nourishment, which would allow the beach to erode 1 meter prior to the next replenishment cycle. It is noted that the existing revetment structure will remain in place. The typical beach fill section is shown in **Figure 5-2**.

In an effort to identify potential sources of beach quality nourishment material to stabilize the shoreline within the City of San Clemente, a fairly extensive field exploration program was designed and implemented. Initially, core samples derived from six vibracore test holes sampled randomly from the vicinity of the San Clemente Pier to San Mateo Point in January 2003 were taken to substantiate the results of the geophysical survey. The test holes were placed at least one mile offshore in order to hopefully avoid the shallow bedrock encountered by the seismic survey. Most of the holes were sampled at a mud line elevation of -16.4 meters (-50 feet), MLLW, which is the limit of the most economical dredging operations. The exploration indicated that at one-mile (1.73 kilometers) seaward of the beach, the bedrock is still fairly shallow as it was encountered between 1.3 meters (4 feet) and 3.3 meters (10 feet) below the mud line. The sediments encountered overlying the bedrock were silts and fine-grained sands, visually deemed unsuitable for beach replenishment. As a result of these unsuccessful efforts, the exploration program was moved to Oceanside near the mouth of the Santa Margarita River, where previous reconnaissance exploration had indicated suitable beach quality nourishment material.

In August 2003, 25 additional vibracore test holes were sampled for a beach replenishment study at Oceanside Beach in San Diego County. The purpose of the study was to determine if there was enough suitable sand for a beach replenishment program at both San Clemente and Oceanside using two separate borrow areas within the zone of exploration. The depth of the holes varied from 14.8 meters (48.5 feet) to 24.1 meters (70.2 feet) (See **Figure 5-3)**. Analysis of the San Clemente and Oceanside Borrow Areas and details of the January and August 2003 vibratory core explorations can be found in Raabe 2003 and 2004. As part of the contract for the January 2003 program, Group Delta, a Geotechnical Engineering Consultant firm, produced a report of project activities and results therein, entitled "Vibracore Exploration Program, San Clemente Beach Shoreline, Orange and San Diego Counties, California" (Group Delta, 2003) for the Geotechnical Branch of the Los Angeles District. Briefly, the investigation of the two aforementioned borrow areas yielded the following results:

<u>San Clemente (Borrow Area #1)</u>: Sampled materials encountered with Borrow Area #1 were generally greenish-gray silty, very-fine grained sands and sandy silts with minor

amounts of shell fragments. A soft, micaceous wackestone bedrock was encountered in several (possibly 4) of the holes, causing refusal of the vibracore. These materials appeared to be too fine grained for beach nourishment purposes. Samples for chemical analysis were not taken, as the recovered sediments were too fine to be placed onto the beach.

Oceanside (Borrow Area #2): The sampled materials were generally fine-grained sands with local silty intervals and minor amounts of shell fragments. Significant laterally discontinuous gravel/cobble beds and lenses were encountered throughout the area, but the thickness generally averaged 2-feet (0.65 meters) or less. Often the gravel intervals possessed supporting dense silty sand material, which acted as a “pavement” holding the cobbles tightly, making core penetration difficult. Shell and shell fragments were encountered throughout the area. Physical tests were performed on 91 samples from this borrow area. The samples show an average of 12.3 percent gravel, 81.4 percent sand and 6.3 percent fines passing the #200 sieve. Twenty-five out of the 27 test holes within the Oceanside site (Borrow Area #2) are beach-compatible, with the total number of fines equaling 12 percent or less.

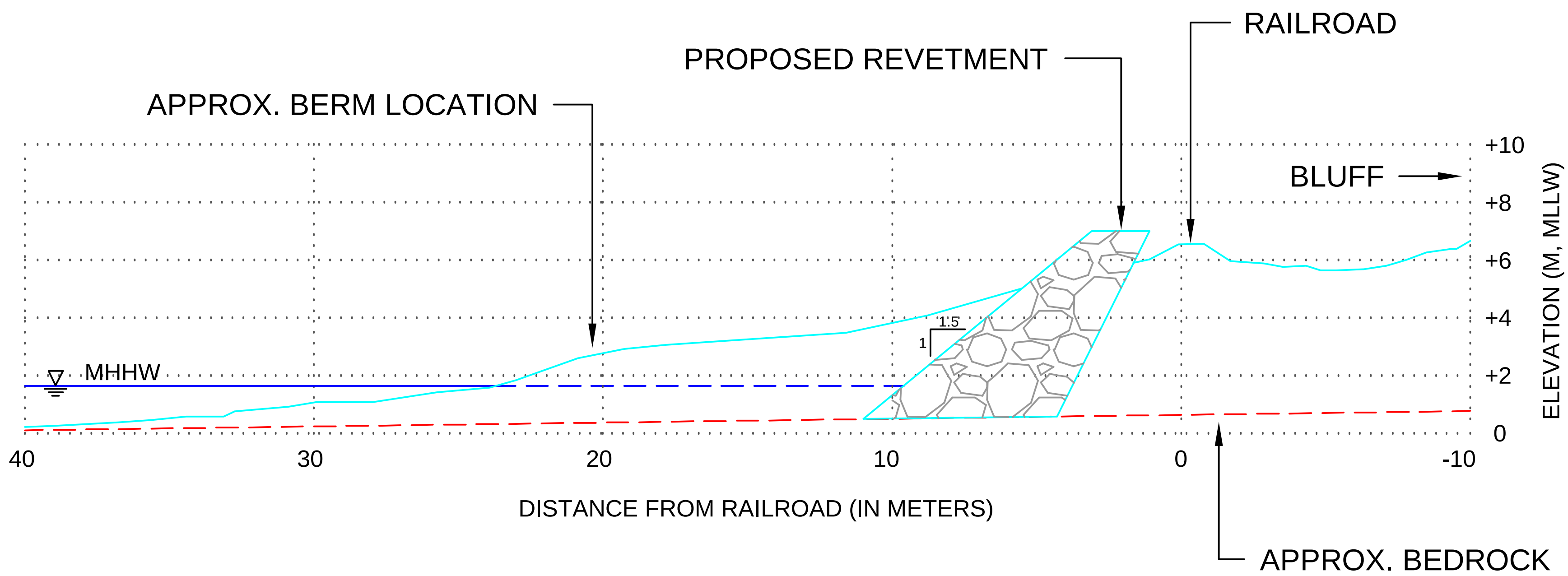
Although the above field exploration only addresses potential offshore borrow sites, the only real onshore locations suitable as a source for beach quality nourishment sand is the Camp Pendleton Marine Base, which is located immediately southeast of San Clemente and/ or perhaps somewhere in the watershed of the San Juan River, near San Juan Capistrano. At the present time, exploration in Camp Pendleton is being considered in only one location behind a debris basin. However, use of this source would require several trucks carrying sand to San Clemente and delivering the sand to the beach via residential streets. In addition, transport of this sand source would be predicated upon the U. S. Marine Corps allowing the trucks onto the Base to remove the sand. The Marine Corps only allows the sand behind the debris basin to be removed at certain times, and at the time of this study the sand was not available.

5.2.2.5 Cost Estimate of Proposed Alternatives

Based on the unit costs presented in Table 4-3, the preliminary alternative costs including initial construction and subsequent operation and maintenance are presented in **Table 5-1**. The cost for beach fill alternative is also shown in Table 5-1 using the average unit cost of $6,560 per cubic meter. The thorough cost estimate will be performed in the F4 analysis.

Table 5-1: Preliminary Cost Estimate for Proposed Alternatives

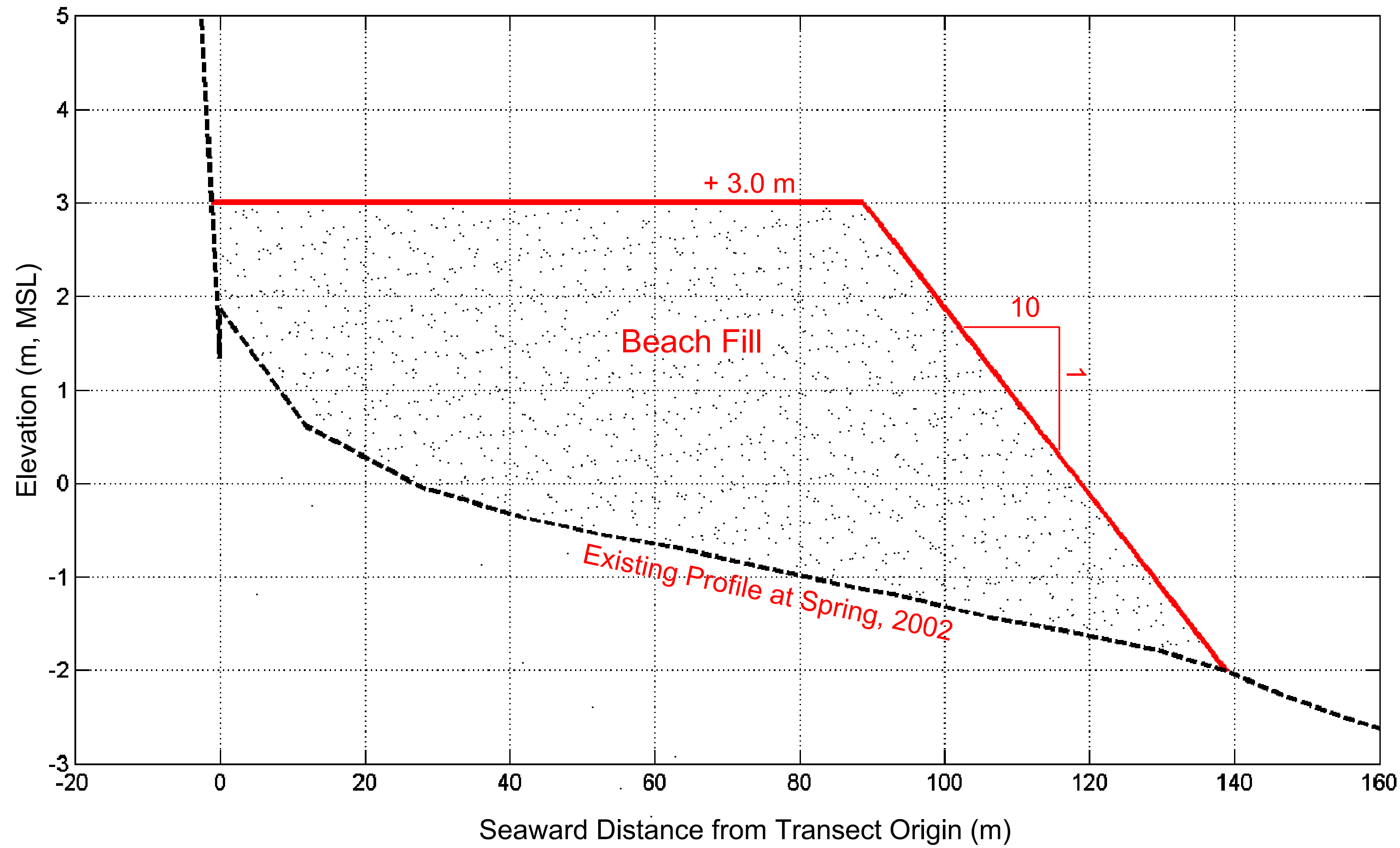
Reach	Length (m)	Alternative Cost ($)		
		Revetment	Seawall	Beach Fill
Reach 1	696	$635,664	$9,534,960	$6,356,640
Reach 2	680	$446,080	$6,691,200	$4,460,800
Reach 3	600	$393,600	$5,904,000	$3,936,000
Reach 4	732	$480,192	$7,202,900	$4,801,920
Reach 5	413	$270,928	$4,063,900	$2,709,280
Reach 6	1040	$682,240	$10,233,600	$6,822,400
Reach 7	1081	$709,136	$10,637,000	$7,091,360
Reach 8	347	$227,632	$3,414,500	$2,276,320



Beach Profile with Revetment

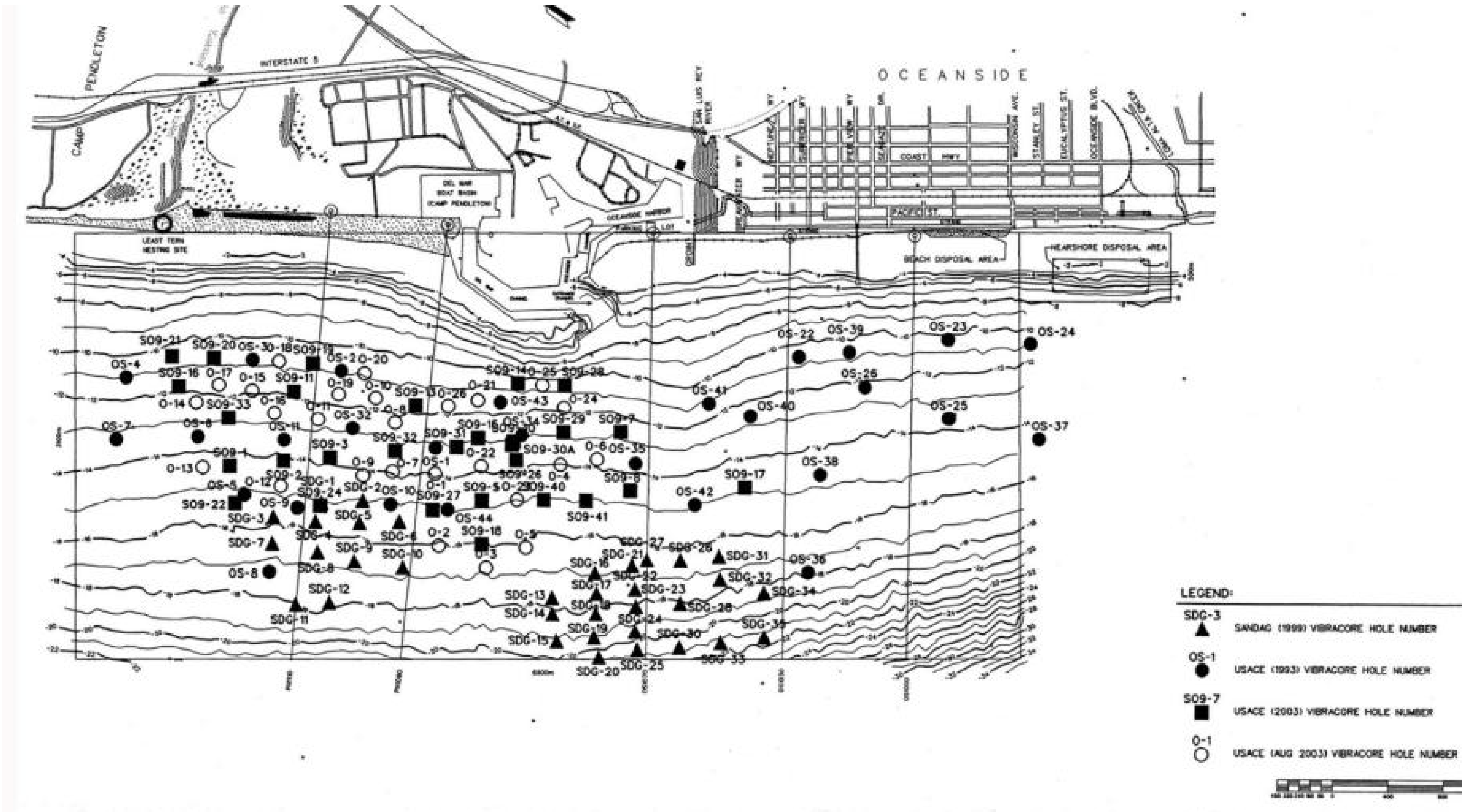
SCALE: 1 INCH = 6 METERS

Figure 5-1



Typical Beach Fill Cross Section

Figure 5-2



Vibracore Hole Locations at Oceanside

Figure 5-3

6.0 SUMMARY OF COORDINATION, PUBLIC VIEWS AND COMMENTS

6.1 Public Involvement Program

A Public Involvement Program was established for the feasibility study, and is being accomplished through representatives from the City of San Clemente, and the Corps of Engineers, Los Angeles District. Activities include:

- The City of San Clemente and Corps of Engineers, Los Angeles District websites will be used to provide information on the study status, updates, meeting schedules and summaries.
- Development of a public informational brochures, project messages, and vehicles for administering public participation in the study and decision making process.
- Preparation of newspaper articles.
- Public Workshops and meetings are to be held to obtain public views, comments, and opinions on factors that should be considered in the study, review of study results, and decision-making on alternatives to be considered and proposed recommendations.

6.2 Public Workshop

A co-chaired public workshop was held on 10 January 2002 at the San Clemente Senior Center to inform the public of the feasibility study and to solicit public input. Additionally, an overview of the NEPA/CEQA compliance regulations was presented along with the announcement of the initiation of the public scoping period. The intent of the scoping process is to encourage participation in the environmental review process from public agencies, special interest groups and the general public in the identification of the key issues and concerns relevant to the scope of the EIS/EIR.

There were about 50 people who attended the public workshop or submitted information, representing a number of agencies, interest groups, and local residents. Some of the agencies and interest groups participating in the meeting included San Clemente Coastal Advisory Committee, San Clemente Marine Safety Division, San Clemente Beaches, Parks, and Recreation Commission, San Clemente Ocean Festival, Capistrano Bay District, Citizens and Surfers of San Clemente, Surfrider Foundation, Restore the Shore/Railroad Corridor Safety Education Panel, and California Lobster and Trap Fishermen's Association.

The response from the general public who attended the session was generally positive. Many of the participants voiced support for efforts to restore the San Clemente Beaches, though there were also many concerns and questions regarding potential adverse impacts.

6.2.1 Public Concerns

A number of public concerns have been identified during the Public Workshop. Additional input was received through coordination with the sponsor and other agencies. The public and agency concerns form the bases of the initial problem and needs statements addressed in this report, and considerations that should be addressed in developing and evaluating alternative plans. The comments and suggestions received have been summarized as follows, in no particular order:

a. Use of groins or other hard structures. There was general opposition and concern expressed on the use of groins or other hard structures to retain sand on the beach.
b. Impacts of revetment and seawalls. Concern was expressed regarding the impacts of revetment and seawalls on exacerbating erosion.
c. Impacts of Dana Point Harbor. Several interests expressed concern with the impact of Dana Point Harbor on sand movement towards the San Clemente Beaches.
d. Impacts of San Juan Creek. Many indicated concern with the impacts of actions in the San Juan Creek watershed, such as sand mining and paving, that is reducing the watersheds sand and sediment contributions to the San Clemente coast.
e. Consideration of managed retreat. Several indicated a desire for managed retreat to be considered as an alternative measure to meet study objectives.
f. Consider aesthetics. An interest expressed the need to consider aesthetics as part of evaluating alternative plans.
g. Desire for continued monitoring. The need to continue monitoring the coast including the beach, surfing areas, and near shore ecosystem was expressed as an important part of any study or project.
h. Impact on nearshore resources and ecosystem. Damage to surf grass and lobsters was noted as a major concern to commercial fishermen as well as recreation snorkeling.
i. High cost of sand rapidly lost. A concern was expressed on the high cost of sand renourishment and the rapid erosion of the material as experienced with recent sand replenishment projects.
j. Time requirements and need for temporary solution. There was concern expressed on the relatively long period of time required to implement a permanent solution, and that a temporary measure should be taken as soon as possible to reduce the current vulnerability of the beaches and associated development.
k. Impacts on surfing breaks and reefs. Concern was expressed on the impact of plans on various surfing wave breaks including point breaks, reef breaks, and beach breaks. These breaks will be impacted differently by different shore protection measures. River delta is going to be impacted strongly, if there is sand dumped there. The beach breaks, basically are going to be heavily impacted by any sand replenishment project.
l. Consider impacts to local businesses and community. The study should consider the impacts of continued erosion and loss of the recreation beaches and the benefits of restoring the beach on local businesses and the community.
m. Analysis of Historic Littoral Cell Conditions . There is interest in an analysis being made of the entire littoral cell to include sediment changes over seasons and time, the impacts of storms, and consideration of developing an equilibrium condition between sand sources and losses along the San Clemente beaches.
n. Artificial surfing reefs. There was interest in consideration of artificial surfing reefs such as Pratt's reef, to be considered in the study, which could improve surfing as well as reduce erosion of the beaches. This could include

consideration of using geo-textile bags to create "narrow neck reefs" to meet these objectives.

o. Opportunistic beach fill program. It was noted that the City of San Clemente has an Opportunistic beach fill program to allow suitable beach material to be placed on the beach as various projects make such material available.
p. Surfing is critical to the community culture of San Clemente. It was noted that the City of San Clemente was one of the centers of developing California's surfing interest, and there are numerous organizations and businesses that support this activity.
q. Railroad relocation. It was noted that there have been discussions regarding the possible relocation of the railroad line as part of high-speed rail, double tracking and other projects. Accordingly, the study should consider the potential for relocation of the railroad including possible beneficial impacts to the beaches and recreation use.
r. Quality of sand. Some concerns were mentioned on the quality of the material to be placed on the beach and the potential for fine silty material to cause impacts to the nearshore ecosystem.
s. Consideration of public safety and public access. It was noted that the existing rail line limits access to the beach and causes major public safety concerns. This should be addressed as part of the study.

It is expected that several other public workshops will be held to discuss the study findings as results become available. A final public meeting will be held to present the complete findings of the feasibility study and to provide the public an opportunity to express their views on the results and recommendations of the feasibility study.

6.2 Institutional Involvement

a. Study Team

During the feasibility study, staff from the Corps of Engineers, Los Angeles District, the City of San Clemente, the State of California Boating and Waterways, and other interests participated in developing and analyzing information for the study. They participated directly in the study effort and on the Executive Committee. This involvement is expected to lead to the general support for the implementation of a *tentatively* selected plan.

b. Agency Participation

During the feasibility study, coordination with the U.S. Fish and Wildlife Service (USFWS) was conducted in accordance with the Fish and Wildlife Coordination Act. The USFWS will be providing the Corps with a Planning Aid Letter Report, draft Coordination Act Report that includes their views on the *tentatively* selected plan and will be included in the draft feasibility report issued for public review. The USFWS will also provide a final Coordination Act Report, which will be included in the final report. All USFWS recommendations have been given full consideration. The USFWS has coordinated their report with the National Marine Fisheries Service and the California Department of Fish and Game. The Planning Aid Report provided by USFWS will present substantial information on ecosystem conditions including types of species and habitats, as well as threatened and endangered species related to the study area. The report also includes a preliminary evaluation of potential impacts associated with the alternative plans considered in the study. Based on this evaluation, the Planning Aid Report will provide recommendations to be considered in developing and evaluating alternative plans.

6.3 Additional Required Coordination

The draft report on the study results and tentative recommendations will be formally coordinated with a number of Federal and State agencies as required by Federal and state laws and policies. The draft report includes a Coastal Consistency Determination, which will be submitted to the California Coastal Commission for their concurrence in the findings. The draft report will also be submitted to the Regional Water Quality Control Office for their approval related to the Clean Water Act as well as regional Air Quality Control offices. The draft report and proposed recommendations will be provide to the State Historic Preservation Officer for their approval on the impacts and recommendations associated with cultural and historic resources. Other Federal and State agencies that will receive copies of the draft report for their review and approval include Federal and State Environmental Protection Agencies, the State Clearinghouse, and other agency interests.

Other organizations that have participated in the study process to date and will be requested to provide formal comments include the following agencies and groups:

Federal Agencies
U.S. Fish and Wildlife Service
U.S. Geological Survey
National Marine Fisheries Service
National Fish and Wildlife Foundation
Environmental Protection Agency

Local Committees/Groups
Surfrider Foundation, International Headquarters
California Lobster and Trap Fishermen's Association
Capistrano Bay District
Citizens and Surfers of San Clemente
Restore the Shore/Railroad Corridor Safety Education Panel
Southern California Wetlands Recovery Project

State Agencies
California Department of Boating and Waterways
California State Resources
California State Lands Commission
California Coastal Commission
California Coastal Conservancy
California Department of Fish and Game
California Regional Water Quality Control Board
California Regional Air Quality Control Board
California State Historic Preservation Officer

County of Orange Agencies
County Board of Supervisors
Orange County Beach Group
Orange County Transportation Authority

City Governments
San Clemente & San Juan Capistrano
San Clemente Coastal Advisory Committee
San Clemente Beaches, Parks, and Recreation Commission
San Clemente Marine Safety Division
San Clemente Ocean Festival

6.4 Report Recipients

A mailing list of Federal, State, County, local and regional agencies, environmental organizations, and interested groups and individuals are available upon request. These interests will receive notice of the availability of the draft and final feasibility report documents and other notifications on report and project decisions and status.

6.5 Public Views and Responses

Public views and comments received as a result of coordination of the draft report and responses thereto will be provided in the final report and EIS/EIR and considered in the final decision process. A summary of the comments received will be presented in future updates of this chapter.

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